COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

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FIG. 1. AIR MOTOR HOISTS IN PRATT & WHITNEY FOUNDRY, HARTFORD, CONN.

COMPRESSED AIR IN FOUNDRY PRACTICE

We present here an abstract of a paper read at the Buffalo meeting of the American Foundrymen's Association by Mr. Arthur F. Murray, East Cambridge, Mass. The paper was copiously illustrated, but the half-tones here presented are from a paper upon the same topic by Mr. W. H. Armstrong, New York city, read at the Boston meeting of the New England Foundrymen's Association. In presenting this matter in this combination we follow the lead of Foundry in its December issue.

To say that no foundry should be without an adequate supply of compressed air is almost as trite as to say that no steam power plant should be without steam. But in spite of the many advantages that the user of pneumatic appliances has over the foundryman who is without them, many foundries throughout the country are without any supply of compressed air and a larger number make less use of it than they should.

It is not the purpose of this paper to present a scientific treatise on compressed air or a mass of figures as to costs of operation and resultant savings. These are so dependent on individual conditions that figures drawn from

general statements would be of little value. I shall merely attempt to outline the uses to which compressed air is put by the wide-awake foundryman.

It may be well to list the more important uses for compressed air in the foundry, starting with the handling and mixing of materials and proceeding through the core and molding shops to the cleaning room and shipping floor.

Applications of compressed air:

Handling Materials.

Air hoists.

Pneumatic elevators.

Pneumatic cupola charging machines.

Fuel oil systems.

Core Shops.

Core carriage hauling devices.

Core sand preparation (pneumatic riddles).

Coremaking machines, jolt ram type.

Coremaking machines, roll over type.

Molding Floor.

Molding machines:

Plain jolt or jarring type.

Combination jarring and squeezing types.

Combination jolt ram and pattern drawing types.

Plain vibrator types, power squeeze types.

Power squeeze, power-draft types.

Power squeeze, power roll-over, power-draft types.

Power sucker types with vibrator.

Pneumatic rammers.

Pneumatic molding sand sifters or riddles.

Blow guns.

Spraying devices.

Cleaning Room.

Pneumatic chippers.

Sand blasts, high or low pressure.

Sand blast tumbling barrels.

The air elevator is used frequently in place of the hydraulic elevator for sand pits or other places where the hydraulic elevator would require the installation of long lines of large piping, expensive pump installations and trouble from freezing. It is simple, cheap and effective, although not to be recommended for the continuous service of the cupola stage. Where the lift is long, indirect air elevators, similar to the indirect hydraulic elevators used in office buildings are frequently employed.

FIG. 2. ANOTHER VIEW OF THE MOTOR HOIST INSTALLATION.

A great many foundries use fuel oil for skin drying, melting furnaces, core ovens, etc. The air displacement system is a simple means of transporting this from the place of storage to the place of use. In this system air is not applied directly to the storage tanks but alter-

nately to two small pressure tanks which receive their supply of oil by gravity from the main storage tanks. Simple cross-over valves are used and are changed over once or twice a day, usually by hand, but sometimes automatically.

Compressed Air in the Core Room.

The core room is often a neglected part of an otherwise up-to-date plant. Therefore, opportunities for savings are usually good. If core costs can be sufficiently reduced, the entire molding practice may be radically changed, coring taking the place of difficult pockets, loose part work or multiple part flasks. Jolt machines for making cores are meeting with increasing favor. For success on core jolt machines, boxes must be substantially built or they will be knocked to pieces. But the cost of a well-built core box is little more than that of a poorly built one, and the use of core jolt machines will reduce most core costs 25 to 50 per cent.

One of the most remarkable changes in foundry practice during the past five years has been caused by the general adoption of the jarring machine, jolt-rammer, bumper, or bouncer, as it is variously termed by makers and users. No other single type of molding machine is applicable to as wide a range of work, or requires as little special pattern and flask work.

One of the most essential requirements for the profitable operation of jarring machines is efficient crane service. Nothing will show up the crane service like the presence of a good sized jarring machine on the molding floor. Inefficient crane service in a hand-molding foundry of course means idle time for the molder, but he will usually not make much of a row about that. When the jarring machine comes in, the foreman and manager are watching it and delays caused by the crane are quickly noted. In properly operating the jarring machine, molds are set up on the floor, clamped, picked up by the crane, carried to the machine and rammed, picked up again and turned over, and then carried to the finishing floor by the crane. In connection with the jar-ramming machine in our foundry, I have found it profitable to install 5-ton independent high-speed auxiliary hoists on each of the two 60-foot traveling cranes, as well as in a 2-ton electric jib crane and an 8-inch air hoist.

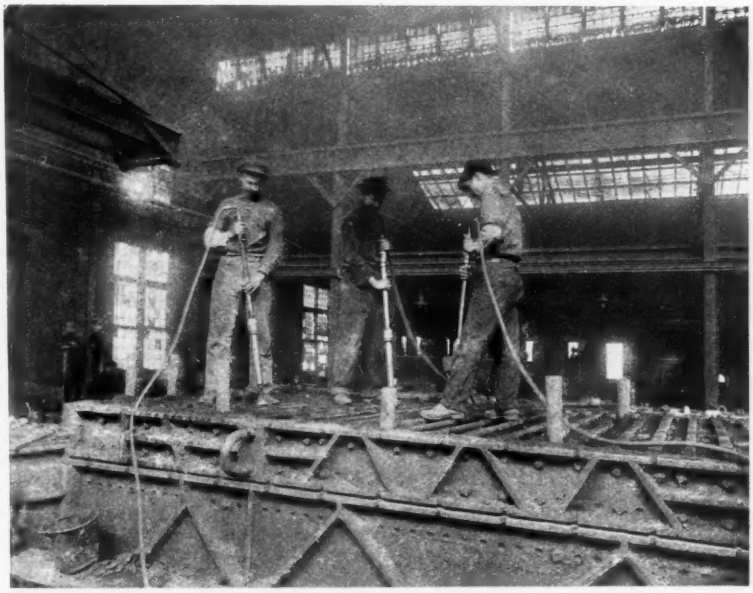


FIG. 3. THE USE OF PNEUMATIC SAND RAMMERS FOR MAKING LARGE MOLDS.

The jarring machine, though covering a wide range of work, is not a universal panacea for high costs and poor castings. For specialty work the plain hand squeezer with vibrator attachment is widely used. For this same class

FIG. 4. HAMMER FOR BENCH WORK.

of work the ramming is sometimes done by hand or on a plain squeezer, and the pattern drawn by a sucker with vibrator attachment.

The very fact that there are so many types of air-operated molding machines. only emphasizes the previous statement that air is to the foundry what steam is to the power plant

The subject of sand-blasting is so broad that it can only be treated adequately in a separate paper. However, compressed air is used extensively for cleaning castings. For cleaning small castings that are not fragile the sand blast tumbling barrel renders excellent service. There are a number of machines built on the principle of a rotating barrel with one or both heads stationary. A nozzle or nozzles from a regular sand blast machine is inserted through openings in these heads. Most of these machines operate on the low pressure system. Some return the sand to the machine by a suction system and some by gravity. They all operate inside of an outer case closed by sliding, swinging or rolling door, and connected to an exhaust system.

An efficient sand blast or sand blast tumbler, either of the high or low pressure type, will remove sand and scale, and will leave castings better looking than either a plain rumbling machine or the emery brick, wire brush and pickling tank. Castings have been cleaned and their cores cut out in less than an hour each with the sand blast that could not be cleaned by hand in two days. I know of one plant where a sand blast tumbling barrel replaced a pickling tank with the result that shipments could be made at least one day earlier than before. The product required galvanizing and was sandblasted and put in the galvanizing bath the day after it was cast instead of losing a day in the pickling vat.

The casting now being clean the fins, etc., are chipped off with a pneumatic chipping hammer. One man chipping with a chipping hammer is as good as two or three with hand chisel and sledge, and the work looks better and smoother. A skilled chipper will quickly remove fins or bunches so that they appear scarcely to have existed.

A few words about the care and upkeep of pneumatic tools. Before attaching a tool, blow out the air line and squirt oil into the valve. Do not use an air hammer all day long without oiling it. If the hammer has not been used for some time, squirt a little kerosene or benzine into it, connect up the hose, operate

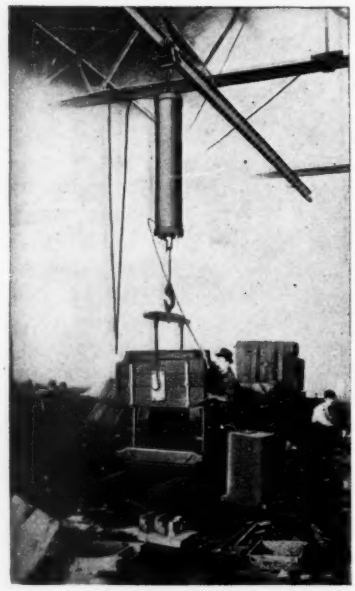


FIG. 5. AIR HOIST FOR HANDLING MOLDS.

the machine for a few strokes, then disconnect and squirt a light machine oil, or sewing machine oil, into the hammer. Several of the large oil refiners now supply a special pneumatic tool oil which should be used if possible. New hammers are always furnished with a gauze strainer. This should be kept in good condition as rubber particles and rust from hose and pipes are liable to clog valve passages if allowed to get into hammers. It is a good plan to suspend the hammers over night in a bath of kerosene to clean them out and to prevent rusting from moisture in the air. They must then be lubricated before using, as the kerosene leaves them dry. There are a number of makes of automatic oilers on the market to be attached to the air line a few feet from the hammer. If none of these is used the hammer should be oiled several times a day. Chisels should be kept in shape and in general the hammer should be treated as if it were a piece of machinery rather than a piece of scrap iron.

FIG. 6. THE USE OF PNEUMATIC CHIPPING HAMMERS FOR CLEANING.

Piping should be as direct as possible with no undrained pockets or loops where moisture can accumulate and where freezing can occur in cold weather. Separators should be installed at low points on the line. These may be either the ordinary type similar to steam separators or they may be air receivers. It is a good plan to locate a steel receiver of 25 to 50 cubic feet capacity at points where there are large flucuations in compressed air demands. This combines the action of separator and equalizer, although it will not sustain the service if the compressor shuts down. Fittings should be of the long-turn type and all shut-off valves of the gate type. All shut-off cocks on taps should be of heavy pattern and good quality. The piping should be installed with care to insure a tight line and should be well-supported so that the joints cannot shake loose. A single ⅛-inch orifice will deliver 21.2 cubic feet of free air per minute at 80 pounds pressure. Hose should be heavy and preferably armored. Quick-acting couplings should be supplied at both ends of the hose to prevent the reprehensible practice of twisting it before screwing it into a tool connection.

After-coolers and reheaters are usually unnecessary with foundry outfits, but where there is a plentiful supply of cooling water the use of a properly proportioned after-cooler will remove nearly all the moisture from the air before discharging the air into the pipe line.

The average jobbing foundry requires a com-

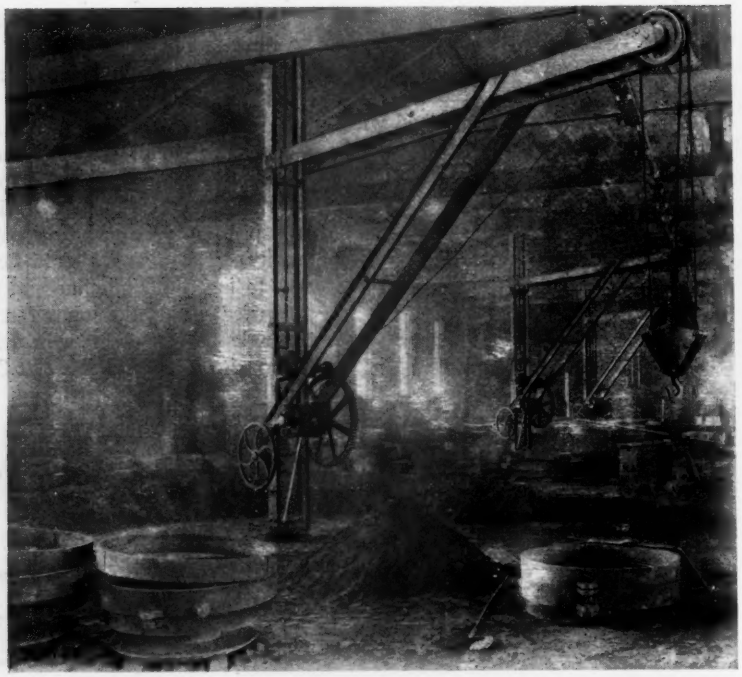


FIG. 7. JIB CRANES PROVIDED WITH AIR MOTORS.

pressor of 300 to 500 cubic feet per minute displacement. Large foundries may use up to 1,500 or 2,500 cubic feet. Specialty foundries frequently require small machines of 50 to 100 cubic feet displacement. In selecting a foundry compressor, price should not be considered so much as service. The foundry compressor should be as nearly dirt-proof and fool-proof as possible. Machines that would give perfect satisfaction when operated in connection with a power plant and in charge of skilled engineers frequently go to pieces when installed in a foundry where skilled mechanics are not available, and where dirt and dust abound. These remarks refer not so much to the large foundry which maintains a power plant either for itself or jointly with other departments of the works, as to the independent jobbing foundry which produces a large percentage of our total foundry product.

In discussing compressed air in the foundry one could easily digress in many directions, for compressed air is so thoroughly applied in the up-to-date casting shop that a discussion of its use is a discussion of modern foundry practice.

EARLY HISTORY OF THE BESSEMER PROCESS

Some interesting early history of the Bessemer process is given by F. P. Wellman, in the *Journal* of the Cleveland Engineering Society, November, 1912. The information presented by him was received at the time of a visit he made to Sir Henry Bessemer, in company with Andrew Carnegie. Bessemer explained that the reason he was first induced to think of an experiment with a new process of iron making was the knowledge which came to him that the emperor, Louis Napoleon, was seeking a material to make better artillery than was then in use.

Bessemer's first idea was that he could make an improved wrought iron by blowing air through the liquid iron, instead of stirring it with a rabble to bring it in contact with metallic oxides, as was the practice in the puddling furnaces. To carry out this idea, he constructed a small stationary converter of firebrick. This was about three feet inside diameter, and much more in height. The pipes, or tuyeres entered at the side not much above the bottom. They were all connected with the

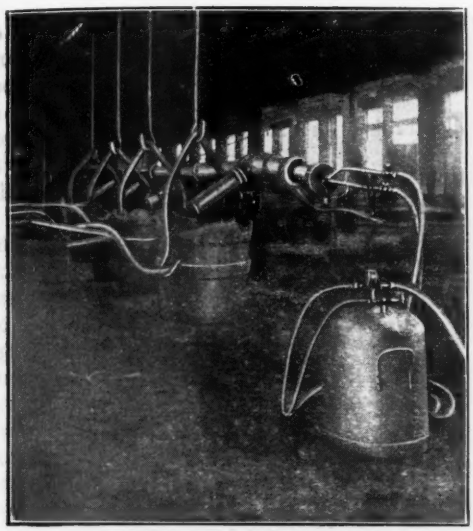


FIG. 8. HEATING FOUR LADLES WITH ONE BURNER.

blast box, which encircled the converter, a pipe leading from this to the blowing engine.

The converter was covered and the hole in the side, near the top, was left as an outlet for the flames. When it was finished he sent to the iron store for a ton of pig iron—no other specification, anything would do so long as it was pig iron. Here was Bessemer's lucky day He knew nothing at that time about the chemistry of iron or what composition was necessary in the iron to make good steel, so it was pure chance that it so happened that the iron, "Blaenavon," sent to fill this order was the only brand made in all England at that time that would have made good malleable steel under the conditions by which it was made. It was low in phosphorus and sulphur, high in silicon, and contained a little manganese.

So the first trial was successful in making a metal that when tried in a neighboring iron works rolled and hammered successfully. The bars were treated in many ways, both hot and cold, and proved to be so strong and tough that it created a great deal of interest in all who saw it. Bessemer said that if the steel had been made from any other brand of iron made in Great Britain that the result would surely have been a worthless metal, brittle and rotten at all temperatures, and that he would have abandoned the experiment at once. Certainly, it was a lucky chance that he sent to that particular iron dealer.

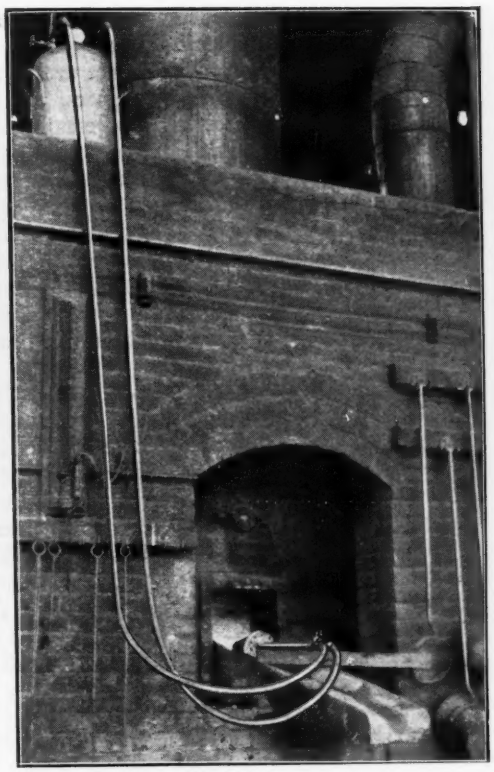


FIG. 9. COMPRESSED AIR OIL BURNER FOR LIGHTING CUPOLA.

COMPRESSING NATURAL GAS*

By E. D. Leland.

The average original rock pressures in the gas fields, 825 lb. per sq. in., in Pennsylvania; 450 lb., in Ohio; 326 lb., in Indiana; 1000 lb., in West Virginia; and 400 lb., in Kansas, have diminished greatly, in some cases to less than atmospheric pressure. On the other hand, consumption has increased enormously. To conduct the required output through long pipe lines of reasonable diameter, it is now customary to compress the gas near the point of production, and sometimes also at relay stations along the line. For example, a 16-in. line 100 miles long, with an initial pressure of 100 lb., and a terminal pressure of 10 lb., would carry about 12,700,000 cu.ft. per 24 hours; raising the initial pressure to 350 lb., would increase the delivery to 41,300,000 cu.ft. Ex-

*Portion of paper before Eng. Soc. of Western Pennsylvania.

haust pumps at the delivery ends of pipe lines have not been found satisfactory.

Gas compressors for this service are practically identical with air compressors, but are designed to operate at higher pressures, and with a medium containing more or less grit. The desirable features of such a compressor are: A long stroke and slow rotation, together involving a piston speed of not over 650 ft. per min.; conical cylinder heads; solid, one-piece, poppet valves with short lifts; removable liners in the compressing cylinders; and adequate piston strength and bearing surface. Water jackets are essential.

For motive power, the cross-compound Corliss engine, direct-connected to the compressing cylinders, is preferred, for the following reasons: (1) Reliability of operation and endurance; (2) ability to start at slow speed; (3) adaptability to the long, slow stroke found most efficient in gas compressing; (4) flexibility and high overload capacity; these are specially desirable features for this work, as the inlet and delivery gas pressures are liable to sudden and violent fluctuations; (5) cheapness compared to a gas engine of equal capacity.

The only serious competitor of the steam engine for this work is the internal-combustion engine, and this the author deprecates on account of its high speed, both while starting, and normally; its inability to handle an overload; its unreliability except under the most skillful management; and the danger introduced by having a combustion engine and an inflammable compressed gas in the same room. The larger sized slow-speed gas engines have been found liable to cracking of the cylinders, due probably to difficulty in jacket circulation, and the present tendency is toward smaller units.

GAS USUALLY USED FOR FUEL

For fuel, most of the compressing plants in the country are now using gas, in the ratio of 1 to 5 per cent. of the amount delivered. At a modern station in West Virginia, the recent test on a 31x68x60-in. Corliss engine showed a consumption of only 13.36 cu.ft. of gas per i.h.p.-hour. Where the market for gas is exceptional, and the compressing plant is near an oil or a coal field, and is on a railroad, the use of these latter fuels is recommended. One ton of Pittsburgh coal, or 180 gal. of Texas petroleum, is about equivalent in heat units to 18,000 cu.ft. of natural gas. The boilers are always situated in a separate building at a distance from the compressors. The cost of erecting a steam-operated plant ranges from $30 to $90 per hp. The operating cost per hp.-hour, ranges from 3.7c. down to 0.71c. in favorable circumstances. The average cost per engine-hour varies from $1.11 to $0.45, depending on the load factor and other conditions.

Further data of this nature were supplied by H. D. Hildebrand, in the discussion following the reading of the paper. Figures are based on 10 plants; five of which were operated by steam and five by gas engine; the average rated capacity of the 10 was 4500 hp.; units of 1300 hp. were generally adopted. Half of the plants were situated on railroads and the other half in remote districts. The average initial cost, including sites and dwellings, was $56.33 per rated horsepower. The operating cost per rated horsepower-year included: Oils, grease, water, packing, etc., $0.62; labor, $1.95; repairs and upkeep, $1.33; total, $3.90, exclusive of fuel, which was gas, of which 23 cu. ft. was required per hp.-hour, costing 2½ to 10c. per cubic foot.

PROFITABLE TO PUMP FROM LOW-PRESSURE WELLS.

The question is often raised as to whether it is profitable to pump gas when the intake pressure is below that of the atmosphere. This depends upon the size of the pool and the porosity of the rock; with a good-sized pool, and an open rock it is profitable to pump against even a high vacuum. In the Indiana field, some of the large compressing stations operated profitably for years with an intake pressure four or five pounds below atmosphere, while at some stations a vacuum of eight or nine pounds was not unusual. Operation under these conditions was strenuously opposed by the oil companies of the district. In the Pennsylvania and Kansas fields many pools are being pumped at rock pressures below one atmosphere.

Gas from the wells contains a quantity of vapor, oil vapor from the vicinity of an oil pool, or water vapor if from contact with salt water. Compression and cooling of the gas reduces its vapor carrying capacity, and oil or water is thereby deposited in the pipe lines. In a hilly country, these liquids are readily drained from the lines by suitable drips placed at low points, but in a flat country like Indiana the problem of keeping long pipe lines free from liquid is a serious one. During the period of greatest production in the Indiana

gas fields this task was successfully accomplished by first cooling the gas from the compressors in a large cooling pond, then conducting it slowly through large pipes, in order to give it time to drop most of its moisture. This cool and partially dry gas then passed through a dehydrating system, expanding ammonia still further reduced the temperature and more liquid was thrown down.

The idea was to reduce the gas to the lowest temperature while it was under the highest pressure, and the result was a practically dry gas for transportation.

As the Indiana natural gas was about 94 per cent. marsh gas, which liquefies at 2700 lb. per sq.in. and 12 deg. F., there was no danger of liquefying the gas under the dehydrating treatment. But this practice resulted in what was probably one of the earliest experiences in recovering gasoline from natural gas. For, in 1902, at one of the Indiana stations which was compressing gas from near an oil pool, we obtained from the drips of the cooling system an average of 80 bbl. of gasoline each day.

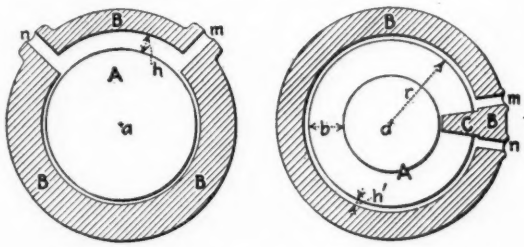


FIG. 1. DIAGRAM ILLUSTRATING PRINCIPLE OF GAEDE'S VACUUM PUMP

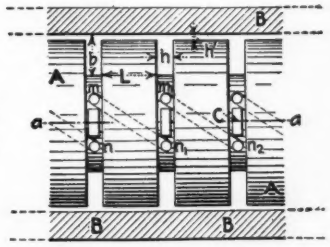


FIG. 2. ROTOR AND CASING OF THE GAEDE PUMP

NOVEL AND EFFECTIVE HIGH VACUUM PUMP

A pump for economically producing the high degree of exhaustion needed for Roentgen-ray apparatus and for metal-filament lamps has been designed by Prof. W. Gaede, of Germany, employing radically new applications of apparently abstract scientific knowledge. The highest degree of vacuum yet recorded has been secured with this pump and in minimum time; yet there is a mechanically free and open passage from intake to exhaust of the machine.

The ideas involved were developed during experiments of the designer in the flow of gases through tubes. The earlier investigators had assumed that, with low pressures, gas molecules were thrown back from the tube walls independently of the angle of incidence so that with a difference of pressure between the two ends (gas molecules heaped at one end more than at the other), as many molecules were thrown to the forward end as were thrown backward. Prof. Gaede found that this was true only for gas pressures below 0.001 mm. Above that figure, a gas film formed on the walls and the molecules were reflected preferentially normal to the wall irregularities which they hit—that is, back toward the direction from which they came. Because of this action of the gas film, the amount of gas flowing through a tube in unit times decreases and the friction between wall and gas increases. In computing the gas friction between moving surfaces it was found that pressure forces appeared which could be applied to the practical design of an air pump for high vacua.

The scheme is shown simplified in Fig. 1 and the application in Figs. 2 and 3. In Fig. 1, *A* is a cylinder rotatable about its axis and inclosed within a casing *B*. In the casing there is milled out a groove extending from the port *n* to port *m* and having a depth *h*. If *A* rotates clockwise, the air in the groove will, owing to gas friction, be carried from *n* to *m*. The pressure difference between *n* and *m* is observable with a manometer and is proportional to the speed of rotation and the viscosity of the gas. On exhausting the casing, the pressure difference between *m* and *n* remains constant in spite of the resulting gas rarefaction because the viscosity is independent of the pressure. If the difference at atmospheric pressure is 760 mm. at *m* and 750 mm. at *n*, then on exhausting the air in the casing to 200 mm. at *m* a figure of 190 mm. is found at *n*. On further reduction to 50 mm. at *M*

there is a value of 40 mm. at *n*. If the pressure at *m* was reduced to 10 mm., then the pressure at *n* should be zero if the relation held and an absolute vacuum would be obtained. But the rule becomes invalid at such low pressures.

At the very lowest pressures, the ratio of the pressures at *m* and *n* is independent of the degree of exhaustion. At pressures below 0.001 mm. the gas film disappears and the gas molecules are diffusely reflected from the surfaces independently of the angle of incidence. The surface of the cylinder may be pictured as shooting out molecules from it in all directions with a certain definite velocity (the natural molecular velocity) depending on the gas. When the cylinder surface moves with a velocity greater than the molecular velocity, then in the groove *h* the molecules shot off from the cylinder in the direction *n* to *m* will have a velocity greater than twice the molecular velocity and no molecules at all can travel backward in the direction *m* to *n*. As a result, at *n* is a region impoverished of gas molecules—a vacuum. Thus while the pump is commercially valueless at atmospheric pressure, it gives notable results when used in conjunction with an auxiliary exhauster.

In the actual construction (Fig. 2) the cylinder *A* is given grooves of a depth *b* and a width *h*. The projection *C* attached to the casing *B* extends down into the groove. The general appearance of this type as made by E. Leybold's Successors, of Cologne, Germany, is shown in Fig. 3. The pump is belt-driven by a 1-3 hp. electric motor, but the belt drives a separate shaft to which the pump rotor is flexibly coupled so as to relieve the bearings. The pump works normally at 8000 r.p.m. The cylinder does not touch the casing at any point and the spindle is supported in the bearings by an oil ring. Nets are placed in the suction tubes to prevent the entrance of foreign bodies. Penetration of oil from the bearings into the exhausted casings is prevented by a special packing; for this to be operative, it is necessary, in starting up, to let the pump run up to speed and then to connect with the auxiliary pump. In stopping, the auxiliary must first be disconnected and then the main pump. All this can be done automatically by motor starters. A large pipe is provided for connection to the apparatus to be exhausted; the small nozzle is for connection to the auxiliary pump.

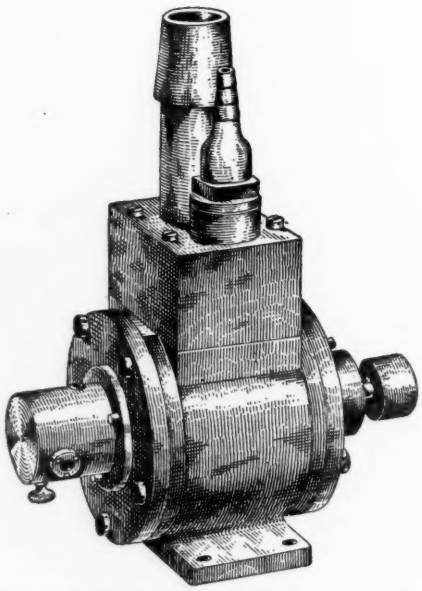


FIG. 3. THE GAEDE HIGH-VACUUM PUMP ASSEMBLED

Several machines of this type have been tested by the designer with average results shown in the following table.

R.p.m.	Mm. auxiliary exhaust.	Mm. final exhaust.
4,000	20.0	3.00
4,000	10.0	0.08
4,000	1.0	0.0003
4,000	0.1	0.00003
6,200	20.0	0.08
6,200	10.0	0.002
6,200	1.0	0.00005
6,200	0.1	0.00001
8,200	20.0	0.005
8,200	10.0	0.0005
8,200	1.0	0.00002
8,200	0.1	0.00000*

*Not readable.

Since the action of the pump depends upon the direct influencing of molecular motion, it was expected that the pump would not only draw off gases but vapors also, in contra-distinction to hitherto employed air pumps. This is confirmed in experiments which have shown that there was no need of employing phosphorus pentoxide or other drying agents, or of freezing out the vapors by immersing in cooling vessels filled with liquid air.

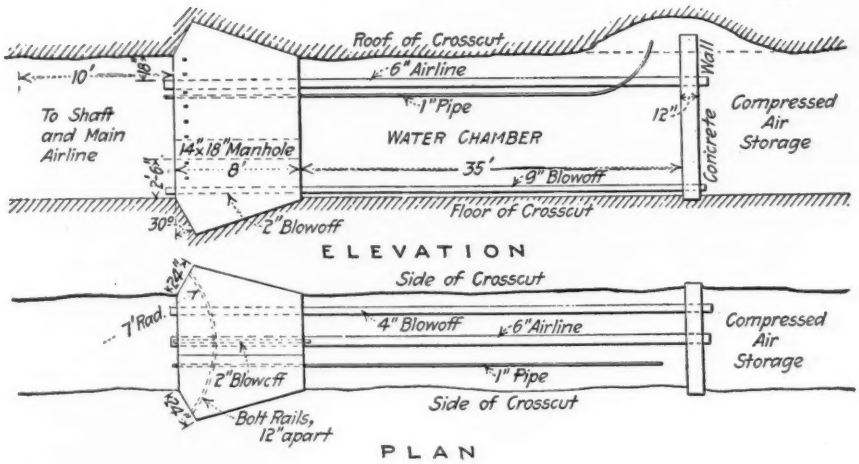


FIG. 1

COMPRESSED AIR STORAGE IN ROCK

BY FRANK RICHARDS.

One of the most familiar annoyances or inconveniences in the use of compressed air is insufficiency of storage capacity. In most of the employments of compressed air, especially in mining operations, the air is used intermittently and the rate of air consumption varies over a wide range. At the same time the usual air receiver is so small as to have little effect in maintaining constant pressure.

It has often been proposed and also many times attempted to use old and abandoned workings of mines for air-storage purposes, but in many cases complete failure has resulted on account of the impossibility of making the rock air-tight. It is, therefore, a pleasure to call attention to at least one instance where this scheme has worked successfully. The storage capacity in this case is a hundred times that of the largest commercial air receiver usually furnished.

Fig. 1 shows the essential features of a crosscut and drift on the 700-ft. level of the Center Star mine of the Consolidated Mining & Smelting Co., of Canada, Ltd., Rossland, B. C., which has been fitted up to serve as an underground receiver. In this case the rock was so close grained and free from fissures that the leakage was inappreciable. Fig. 2 is a plan of the workings appropriated for the receiver, the dam beinng placed as indicated. At this point the the rock was notched out so as to give a bearing at least two feet wide all

FIG. 2

around to take the thrust caused by the air pressure, which aggregated about 450 tons. The dam was made of concrete eight feet thick, reinforced as seen in Fig. 1, by nine horizontal arched rows of 30-lb. rails. A manhole, 14x18 in., was run through the middle of the dam and secured by a cover on the inner face.

Inside the dam, with a space of 35 ft. between, was erected a concrete wall 12 in. thick to form a water chamber between it and the dam. It will be observed that this wall had to resist only the water pressure of four or five pounds at the most, the air pressure being effective equally on both sides, communication being free over the top of the wall.

The air communication between the main

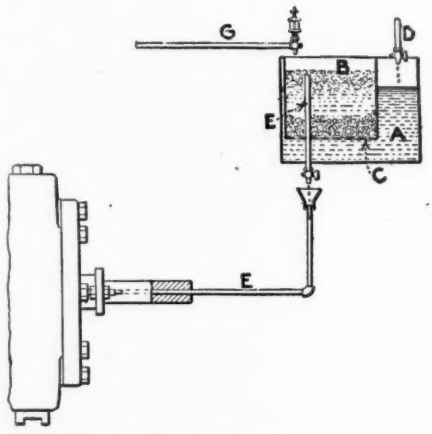
air line and the storage chamber was through the 6-in. pipe, this passing through the water chamber on the way. Any water which might accumulate in the bottom of the storage chamber could be drawn off through the 4-in. blow-off, while the 2-in. pipe would discharge the water from the water chamber when required. The function of the 1-in. pipe is not clear, but it could be used, like a try-cock on a steam boiler, to show whether or not the water was up to the turned-up head of the pipe.

How the water chamber was kept filled does not appear, but a pump must have been required for the purpose. It does not appear in fact how much the water scheme was used, Fig. 1 being from a blueprint made before the storage system was put into use. The air, so far as the storage function was concerned, was entirely independent of the water and we know that the storage is a permanent success. All necessary valves and gages were, of course, provided outside to keep the engineers fully informed and in full control. For the information embodied in this article I am indebted to George A. Ohren, of the Canadian-Ingersoll-Rand Co., Vancouver, British Columbia.—*Eng. and Min. Journal.*

SOAPSUDS LUBRICATOR FOR AIR COMPRESSOR

The cut is a sketch of a soapsuds feeder attached to a single stage air compressor as described by Martin McGerry in a recent issue of *Power*. The air is delivered at a pressure of 90 to 100 lbs. and the temperature therefore is high with the common result that carbonaceous material coats the valves and accumulates in the cylinder passages and in the receiver and pipes beyond. To overcome this trouble soapsuds have frequently been used as a lubricant with good results and descriptions of apparatus employed for the purpose are to be welcomed.

The lubricator consists of a small galvanized-iron water tank *A*, about 7x6x12 in. Inside of it a smaller one *B* is soldered to the large one with its bottom 2-in. above the bottom of the large tank. In the bottom of the small tank are a number of ⅛-holes at *C*. Soft brown soap, cut into small pieces, is put into tank *B*. Water is then fed into the large tank through a ¼-in. pipe *D*, and passing through the small holes at *C* dissolves the soap and



SOAPSUDS FEEDER.

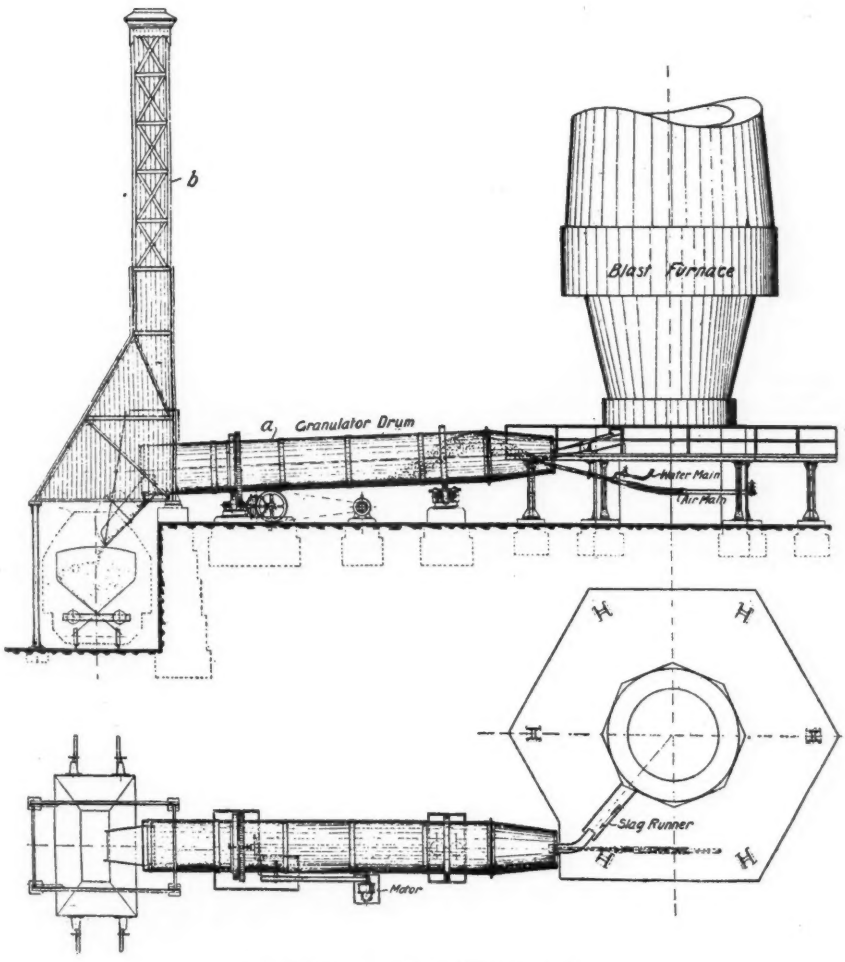
rises to the top of the ¼-in. pipe *E*, through which it passes down into the inlet of the compressor. The water is regulated by the valve in pipe *D*, the small cock under the tank being left wide open.

Just before shutting down the compressor the water is turned off at *D*, and oil is fed into the small tank *B* from a cup *G*, and the compressor is run with oil for a half hour to prevent rust formation. Soap is used that will sink in the water; otherwise small chips will float and pass down through the pipe *E*. This lubricator is used on a 14x18-in. compressor, and when running at 150 r.p.m. with an air pressure of 90 lb., the water is fed at about 45 drops a minute.

AIR-GRANULATION OF MOLTEN SLAG

Blast-furnace slag granulated in a stream of cold water possesses hydraulic properties which are utilized in the manufacture of bricks and of cement. Granulated slag obtained from hot blast furnaces, contains up to 30 per cent. of water, and when used new, without being stored, as much as 40 per cent. of water. For the manufacture of cement it is necessary to completely remove this water by artificial drying, which process necessitates extensive drying plant and considerable outlay for fuel, repairs and labor.

Attempts have therefore for many years been made to discover a method of granulating slag by which the granulated product would be obtained dry and cool. In fact, a considerable number of apparatus have been proposed, some of which have been patented,



BUDERUS SLAG GRANULATING PLANT.

for producing such granulated slag. Such apparatus have operated either by directing by means of a nozzle a jet of steam or compressed air against a stream of molten slag, whereby the latter is broken up into a shower of small particles of slag, or by causing a stream of slag, as it flows from the furnace, to fall on to a rapidly revolving body, such as a disc or wheel, by which the slag is likewise thrown off in a granulated form. In both cases, the grains of slag are caused to impinge against stationary cooled walls. But notwithstanding that the walls are cooled, the slag adheres thereto, especially when large quantities are being dealt with continually, because the drops of slag are still so hot that they adhere to the walls, where they form lumps which fall down as such when they become too heavy. The product consists therefore of unequally cooled slag, some of which is still red hot, varying in size from that of grains of sand to large lumps.

In the case of such apparatus only a partial air-granulation of the slag can be achieved because a portion of the slag, owing to this adhesion, has not been sufficiently chilled by the spraying process and therefore loses its hydraulic properties. An apparatus which is destined for the subsequent utilization of the slag for the manufacture of cement must therefore not only spray the slag, but it must provide continually cool and clean cooling

surfaces for the sprayed slag, on which each drop of slag is cooled individually and from which it is removed rapidly and automatically in order to allow the next drop to be likewise rapidly chilled; and by such a process alone can the hydraulic properties of the slag be preserved.

Acting on these lines, Mr. G. Jantzen, the works manager, has designed and erected a plant at the Buderus Iron Works, at Wetzlar, which is illustrated herewith. The slag channel from the blast furnace projects into an inclined rotating iron drum *a*. Beneath this there is a blast pipe terminating in a wide nozzle directed against the stream of molten slag flowing out of the channel. In this manner the slag is sprayed and immediately thrown against the shell of the rotary drum or propelled in the direction of its axis. The slag particles thus move over a large portion of the cooling surface of the drum, which can be cooled wholly or partly by spraying water on the outside, so that the slag is effectively cooled. Owing to the rotation of the drum, a fresh surface is constantly presented for the slag to impinge against. The slag in travelling through the drum, which is fitted with scoops, is continually turned over and exposed to the current of air, so that the slag particles, as they leave the drum, have the consistency of sand and are sufficiently cool for immediate removal by mechanical means. This sand does not contain any lumps or caked masses of slag, but consists of loose grains not exceeding the size of cherry-stones.

In the installation in question, the granulated slag sand falls directly from the revolving drum into the bucket elevator, which convers it into a storage bin, whence it is transported by an aerial railway to the cement works. But the sand might equally well be charged into railway trucks, as shown in the figure, preferably self-discharging trucks. The lower end of the revolving drum and the elevator pit are situated in an entirely covered space provided with a chimney *b* to carry away the fumes resulting from the granulating process, to a sufficient height to prevent them being a nuisance to the neighborhood. In order to prevent the formation of slag wool in the slag, means are provided for moistening, as required, the current of air used for spraying the slag.

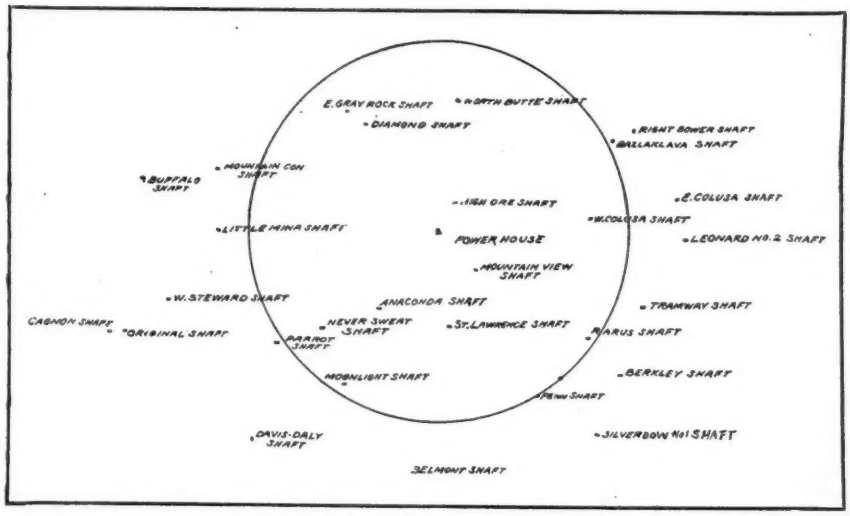
The above-described installation for the air-granulation of molten slag has been in continuous operation at the Sophienhütte Works of the Company for over a year, with a daily output of 100 tons of slag sand of the kind above described. With a drum of 72 in. diameter by 50 ft., the capacity depends only on the quantity and pressure of the current of air employed which has been taken so far from the blowing engine. However, since it is intended to apply air granulation to all the furnaces, the management have decided to install a separate turbo-blower, which will require about 10 h. p. to supply the present requirements of air for the furnace. The revolving drum and the bucket conveyor require about 8 to 9 h. p.

COMPRESSED AIR HOISTING AT BUTTE

By Thomas T. Read.

The substitution of compressed air for steam in operating the hoists at the numerous shafts of the Anaconda Copper Mining Co., at Butte Montana, is perhaps the most interesting event of recent years in power-plant engineering. The relative advantages of compressed air and electric power for this work have been vigorously discussed by mechanical and electrical engineers. But differential equations defining the relations of volumes, pressures, and temperatures are matters concerning which the average engineer knows little and cares less, and I propose in the following paragraphs to present merely a general description of this interesting and important power-plant, avoiding so far as possible all points of dispute, and hoping thereby to avoid being drawn into a controversy with which I have no concern.

The hoisting shafts of the Anaconda Copper Mining Co. are scattered over the hills north of the town of Butte, and are at elevations of 5600 to 6200 ft. above sea-level. The new central power-house is at an elevation of 6080 ft. The relative position of the different shafts is shown in Fig. 1, and the circle, drawn with a radius of ½ mile and with the new power-house as a centre, serves to indicate the distances involved. At these shafts steam-driven hoists, rated at 3000 hp., and hoisting 5-ton skip-loads of ore at the rate of 2800 ft. per minute, have been in operation. Each shaft is also provided with a smaller hoist, locally known as a "chippy," for handling timber and general supplies for work under-

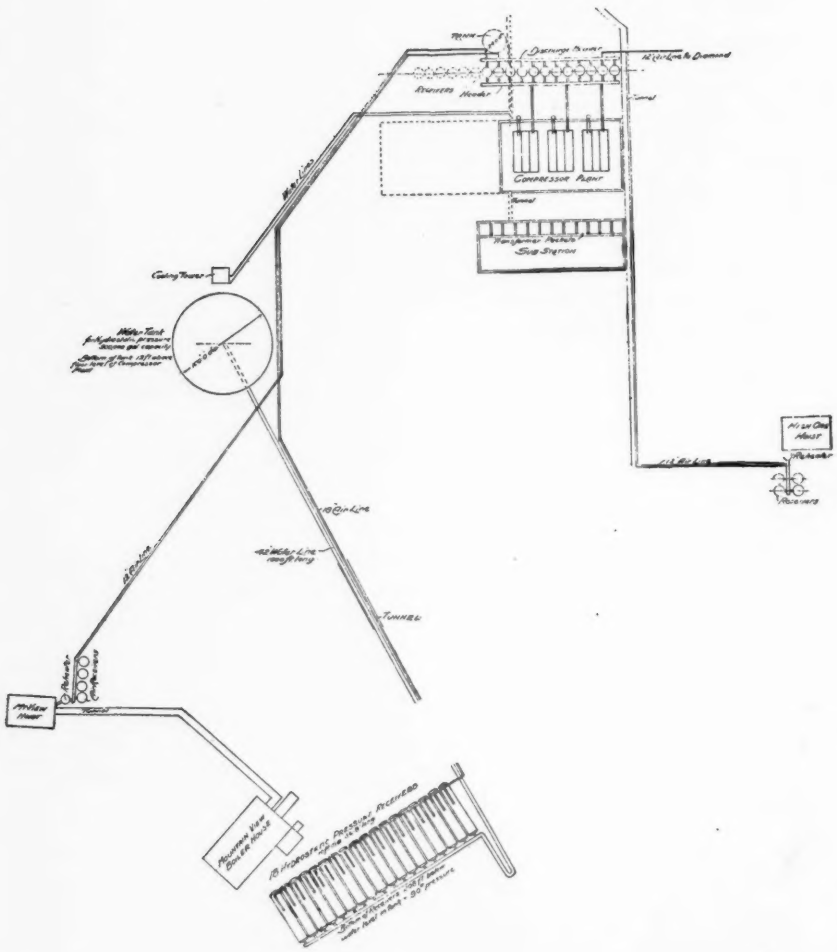


DISTRIBUTION OF MINE SHAFTS AT BUTTE.

ground. Hoists are operated on both shifts, the actual time which the main hoist is in motion being, according to B. V. Nordberg, about 5 hours out of the 24. Each shaft was provided with a boiler-plant, with its necessary labor, and coal, costing $4.50 per ton, was distributed to the shafts. The advantages of operation from a central power-station which could counterbalance the fluctuations in the power requirements of the individual hoists is evident. The recent growth of hydro-electric power development in Montana has made available at the mines an ample supply of electric energy, generated at the plant of the Great Falls Power Co., near the town of that name, on the Missouri river. This is transmitted 130 miles from Great Falls to Butte, at 100,000 volts, and is transformed to 2400 volts for use at the mines. The cost of electric power is $35 per horse-power-year, and when the full supply of electric energy became available about two years ago, it was at once decided to use it in place of coal, as a source of power supply. The question remaining to be decided was what medium of transmission of this energy could be employed to the greatest advantage.

Several methods of doing this were feasible. Electric hoists might have been placed at the shafts, this making the Great Falls plant the central station. But so simple an arrangement as this would have caused fluctuations in the power transmitted through the long transmission line that would have resulted in peak-loads of prohibitive magnitude, and to equalize the consumption of electric power some form of compensating device would therefore have been necessary. Storage batteries are not satisfactory for mine work; the loss of energy in converting electric energy into chemical energy and the latter to electric energy again, the cost of construction and maintenance, and their constant deterioration has led to a discontinuance of their use for this kind of work. The Ilgner transformer has given good results in Germany and elsewhere when employed for hoists which are in nearly continuous operation, but cannot be utilized to advantage on hoists which are idle a large part of the time. It was therefore decided to use the electric energy to drive air-compressors at the central station, the air being stored in a system of receivers and air-lines which distribute it to the hoists. It is then reheated and used in the rebuilt cylinders of the old steam-hoists. I will first describe the power-plant, as its advantages can then more easily be indicated. The plant is still under construction, but for the sake of clearness and convenience I will describe it in the form it will have when the construction work now under way is completed.

The electric energy from Great Falls is delivered at the transformer house, seen in Fig. 2, and transformed to 2400 volts. Six Westinghouse A. C. synchronous motors, of 1200



PLAN OF COMPRESSED AIR INSTALLATION.

hp. each, drive 6 Nordberg cross-compound air-compressors having 30 and 50-in. diameter cylinders, each compressor being rated at 7500 cu. ft. per minute. Three of these compressors are fitted with variable-capacity valve-gear and the other three are of uniform capacity. The air is compressed to 23 lb. in the low-pressure cylinder, passes through the intercooler, and is compressed to 90 lb. This pressure was chosen so that any excess air above the requirements of the hoists can escape through a safety-valve into the mine system and be used to supply the rock-drills, thus relieving the compressors now used for that purpose. The load on the motors is thus kept absolutely uniform during the 24 hours of the day. The method of supplying air for excessive demands will be described in a moment. In starting an air-compressor air is introduced from the receivers for that purpose, so that one may be started and another stopped without causing any variation in the electric power-load. It is expected that five compressors will serve to meet all the ordinary requirements of work. Since construction work was started, the daily output of the mines has been increased from 12,000 to 15,000 tons per day; the load on the power-house is therefore somewhat dependent upon the market price of copper.

The air from the compressors is delivered to

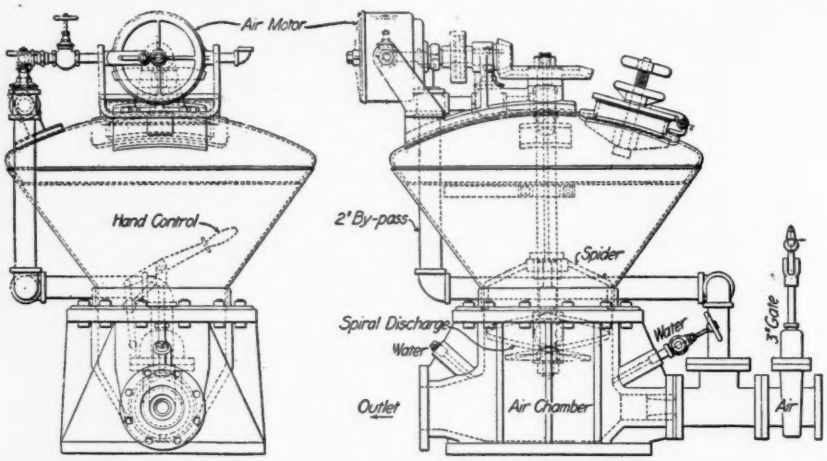
a battery of 18 vertical cylindrical receivers 10 by 30 ft. and of a capacity of 360,000 cu. ft. of free air, when compressed to 90 lb. As these receivers are 50 or 60 ft. distant from the compressors a small receiver is placed above each high-pressure cylinder. These receivers are connected by air-lines with the receivers placed at the hoists; four receivers of the same size as those just mentioned being placed at each hoist. They are also connected with the storage equilibrium system, seen in Fig. 2, which is an essential feature of the design. The receivers just mentioned are connected by an 18-in. air-line with 16 horizontal receivers, each 10 ft. in diameter, and 56 ft. 8 in. long, placed on the hillside a short distance above the Leonard shaft. These receivers are connected by a 42-in. water-line (having a 25-foot loop at the bottom for safety) with a 500,000 gal. water-tank on top of the hill a short distance south of the power house. When the water in the tank is 8½ ft. deep it stands 208 feet above the receivers, thus giving a pressure of 90 lb. per square inch. When the air consumption by the hoists exceeds the supply from the compressors the water flows down into the lower receivers, displacing the 66,840 cu. ft. of compressed air which they contain (equivalent to 568,000 cu. ft. of free air). This storage system not only serves as an equalizer of the load upon the central power-house, but in the event of the total failure of the electric power, the stored air will serve to operate each hoist for twenty minutes, thus making it possible to hoist out the men at work underground. It should be noted that this reserve remains available indefinitely until it is used up; whereas with an Ilgner transformer it would be necessary to utilize the power of the transformer at once, perhaps before it would be possible to collect all the men at the stations.

Four air receivers are provided at each hoist. The air on its way to the hoist passes through a sectional surface heater of special design, 50-in. diameter and 25 ft. high. The heat is furnished by a 50-hp. return tubular boiler, giving steam at 200 lb. pressure and serving to reheat the air to 300 degrees F. The coal used for reheating the air amounts to 1-3 lb. per horse-power hour. As the steam hoisting engines were operated at from 120 to 150 lb. steam pressure and the air is at 90 lb. the hoists have been altered by removing the old steam cylinders and replacing them with larger ones, this being the only change necessary. The valve-gearing of these cylinders is so constructed that the full power can be turned on to secure the necessary acceleration, and when the skip begins to approach the top the speed of engine is checked by compressing air in the cylinders, which is accomplished by means of a compression lever operated by the engineer and by which means the exhaust valves are made to cut off at any desired part of the stroke, thus compressing the air in the cylinders and delivering it back into the main system. The speed of engine can also be checked by reversing the valve gear and compressing air in the cylinders, which is drawn in through the exhaust pipe and delivered into the main system as before. The energy which would ordinarily be wasted in useless friction on the brake shoes is thus returned to the storage system to be utilized on the next trip. The valve mechanism required for this purpose is extremely simple, and the hoist men are stated to prefer to operate the air hoists rather than the steam-driven ones.

It will be noted that this system required the minimum amount of change in the present equipment. In the steam hoists, many of them of the flat-rope type and large enough to operate to a considerably increased depth, no further changes were necessary than the replacing of the cylinders. If electric hoists had been employed it would not only have been necessary to discard the steam hoists, but the surface plant would have required reconstruction, since the floor space required for an electric hoist greatly exceeds that of a flat-rope hoist.

Many of the advantages of the compressed air system in meeting the governing conditions at Butte are evident from the description. It must not rashly be inferred that compressed air, like a patent medicine, is good for all hoisting troubles. In this case, however, where a large number of hoists are to be operated from a central power plant, compressed air forms a useful means of power transmission because it is elastic and can be stored. In this way the occurrence of high peak loads can be automatically and mechanically prevented. This is aided, of course, by arranging the regular hours for hoisting at the various shafts so as to distribute it throughout the day, as far as possible. The hoists at the Mountain View, Diamond, High Ore, West Gray Rock, Leonard, Tramway, and Pennsylvania shafts have already been converted to the use of

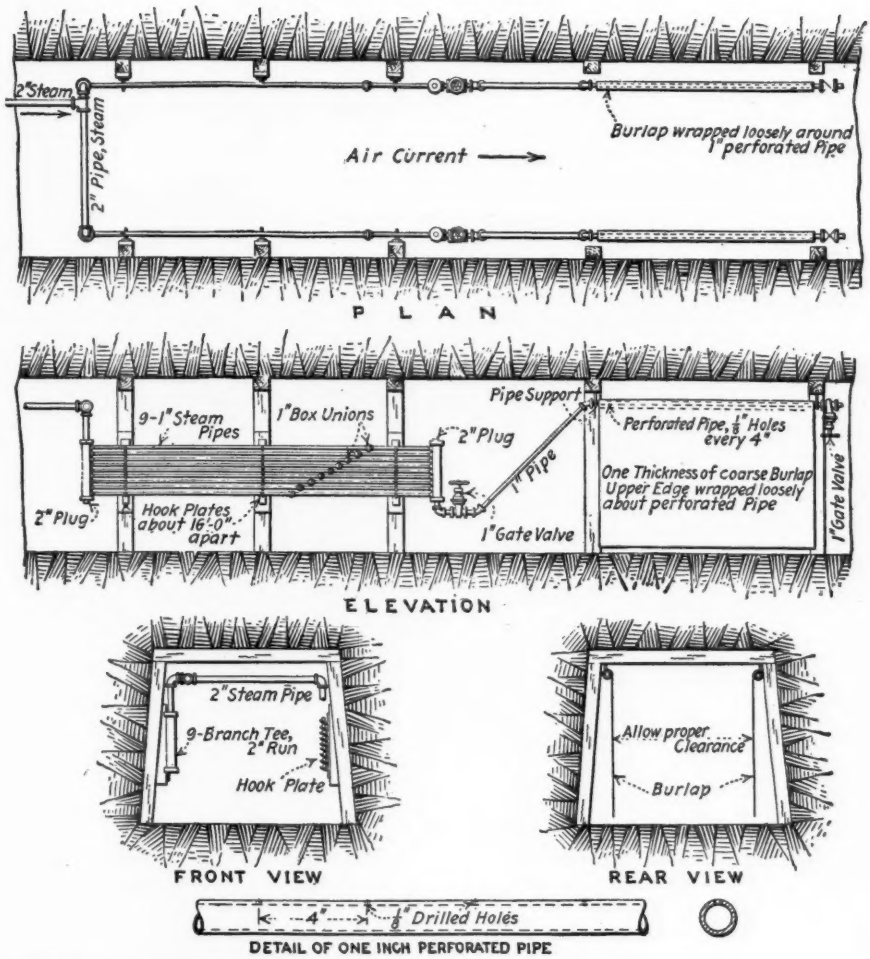
compressed air and 7000 tons per day is now being hoisted by the compressed-air hoists. The other hoists will be converted one at a time, as it is necessary to interfere as little as possible with the regular output of ore. The theoretical efficiency of the plant is stated as follows: motor efficiency, 95 per cent.; mechanical efficiency of compressors, 90 per cent. efficiency of air compression, 83 per cent.; efficiency of hoist, 50 per cent.; total efficiency without reheating, 35.48 per cent.; efficiency after reheating, 53 per cent. Thus 1.88 hp. of the compressor motor is equivalent to 1 hp. at the hoist. In closing I wish to express my obligation to John Gillie, C. W. Goodale, B. H. Dunshee, and W. J. Lilly for the facilities which they so kindly accorded for observation of the plant and securing data regarding it.—*Mining and Scientific Press,* San Francisco.



NEW TYPE OF CONCRETE BLOWER

A machine for distributing concrete by compressed air has recently been perfected by W. Van R. Whitall, Inc., New York City. The blower, the main features of which are shown in the accompanying drawing, comprises essentially a steel drum or receiving hopper bolted to a cast steel discharging chamber. A central shaft passes through the drum to a spider at the bottom, below which is a spiral discharge into the air chamber. This shaft is connected through bevel gears to an Ingersoll-Rand four-piston air motor. On the top of the drum is an opening, fitted with a hinged cover, through which the materials are admitted. A steel bar with knife edges is bolted to the shaft and, rotating with it, prevents possible arching of these materials in the drum. The air is admitted through a hand-controlled valve to a flanged pipe leading directly to the air chamber. A 2-in. by-pass leading to the air motor is placed in this pipe in front of the air chamber. In this way the operation of the machine starts simultaneously with the admission of air to the line. Globe valves are placed on this by-pass line to permit of proper control of the pressure. Water is admitted through two connections at the front and the back of the air chamber. The front connection is used for grouting purposes and the back one for mixing the concrete. The pressure at the compressor is 85 lb. per square inch, but the entrance valve is choked down to reduce the pressure to less than 60 lb. at the chamber. The concreting materials are spread in alternate layers of stone, cement and sand and shoveled directly into the drum. As they pass from the latter into the air chamber the water spray is encountered and the combination of air pressure and water results in a thorough mixing of the materials.

One of these machines, with a capacity of 3 cu. ft. has been used in building a 4x5-ft. concrete drain for the city aqueduct of the New York Board of Water Supply. The machine was placed at the bottom of the shaft 42 ft. from the surface and charged from the top through wooden chutes. About 300 cu. yd. of 1:2:4 concrete have been thus placed. Under these conditions about 3 minutes were required for charging and 45 seconds for shooting the concrete through 125 ft. of 5-in. pipe to the forms.



PRACTICAL HUMIDIFICATION OF MINE AIR

B. J. Matteson, assistant manager of the Colorado Fuel & Iron Co., in his remarks before the Rocky Mountain Coal Mining Institute, gave the following description of a method of humidifying mine air which has been used with marked success in the mines of his company.

A radiator is placed on both sides of a heading through which the entering air passes. Its construction is clearly shown by the accompanying drawing. Live steam is passed through it and the waste steam which is discharged is conducted to a perforated pipe through the 1-in. gate valve shown on the drawing.

Attached to this perforated pipe is a curtain of burlap or brattice cloth, the purpose of which is to bring the moisture or condensed steam in contact with the air current. As the air passes over the radiator it is heated and its capacity to pick up moisture correspondingly increased.

It then passes over the saturated curtains and its humidity is raised to the dew point. The air usually reaches the inby end of the cloth screen at a temperature of approximately 70 deg. F., and as the air current passes through the mine, a deposit of moisture is secured by the lowering of the temperature of the air to that of the mine.

The operation of the radiators has been very successful and has enabled us to keep all parts of the workings in a moist condition. In Col-

orado, the relative humidity of the atmosphere in the winter time does not average above 15 per cent. and much water must be furnished the air or it will dry up the mine in its passage.

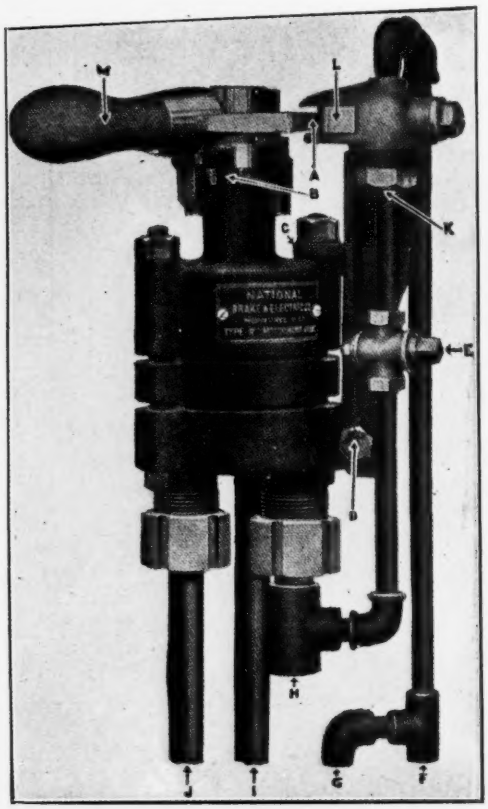


FIG. 1.

THE JOHNSON AIR-BRAKE SYSTEM

In line with the modern tendency in electric railway operation to eliminate the human element as far as possible, Mr. Oscar Johnson, of Chicago, has devised a system which should be an inestimable aid to the motorman in cases of emergency. By means of this system the motorman is able to perform four distinct acts at one operation, namely, ring the gong, sand the rails, turn off the power and apply the brakes. There is consequently no possibility for him to become confused and do the wrong thing. The Johnson system, moreover, insures the performance of these various necessary acts in their proper rotation. For instance, should the motorman fail to turn off the pow- in advance of operating the brake-handle, the device will do it for him automatically. Sand is also applied at the proper time, thereby increasing the braking power and preventing the slipping of wheels, as the sand is applied to the rail before the brake takes effect. If the brakes are applied without the use of sand and the wheels are sliding, the sand cannot be dropped under the wheels and the brake must be released before the sand can be applied. Sand being applied under these conditions makes it impossible for wheels to become flattened. With this system the conductor also is able to perform, at his end of the car, all of the functions of the motorman in case the latter should lose his head or become disabled

Fig. 1 is an assembled view of the parts to the motorman's valve shown as operating in an emergency position. *A* indicates the cam of the handle *M* entered into the supplementary valve as indicated at *L* which simultane-

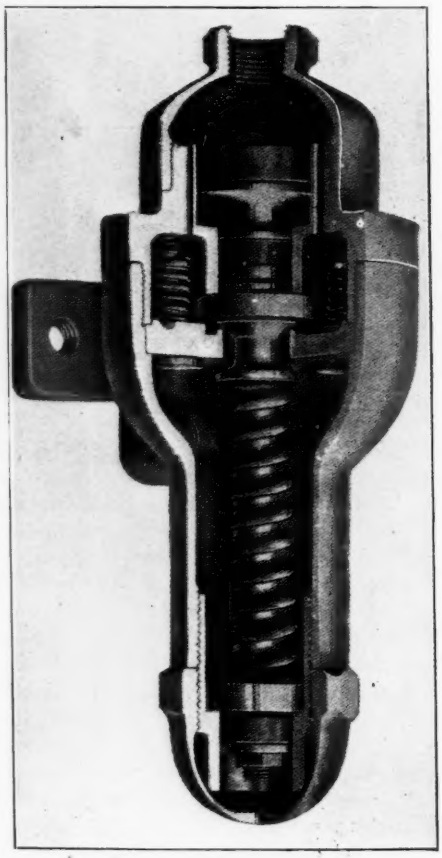


FIG. 2.

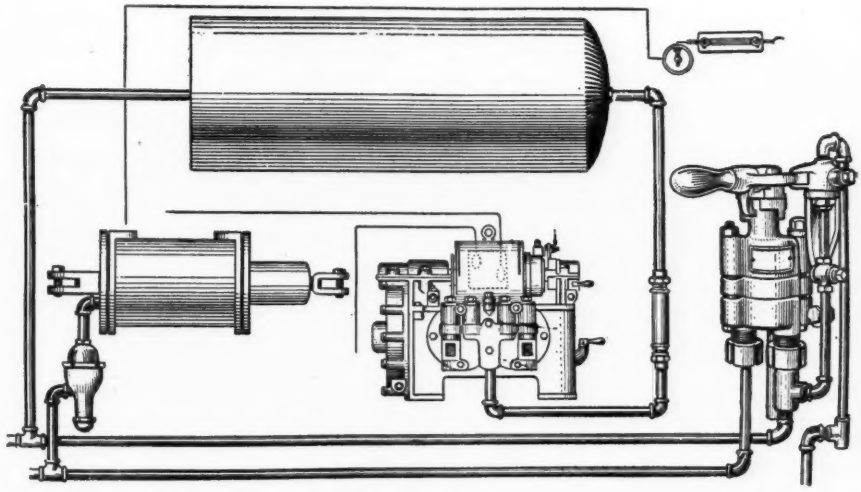


FIG. 3.

ously rings the gong and deposits sand on the rail in advance of applying the brake indicated at *B*. In the ordinary operating position, the handle is quarter turned so that the cam is disengaged from the supplementary valve. The bracket is shown attached to the motorman's valve at *C* and *D*. A stopcock indicated at *E* is provided for in the supplementary air line, which branches off to the gong and sand, as indicated by *F* and *G*, also shown in Fig. 4 at *R*. The supplementary valve is fastened in the bracket and the pipe line thereto as indicated at *K*. The main reservoir pressure enters into the motorman's brake-valve at *H*. The ordinary exhaust-pipe is indicated by *I* and the train line by *J*.

Fig. 2 shows an especially designed reducing valve for creating a uniform pressure to the brake cylinder. Oft times the governor varies between minimum and maximum pressure from 20 to 25 lbs. Figuring on an 8-in. brake cylinder, in general use on electric railways, would mean a difference in braking pressure of 1,000 to 1,500 lbs. on the piston. This valve can be set at whatever brake leverage is figured at and maintained. The valve is especially useful where trail cars of a lighter weight are used, as the valve can be set for the trailer for 30 or 40 lbs., and the motor car be braking at 60 or 70 lbs., or whatever the valve may be set for, according to the weight of the car. Where straight air is used for trailer service, with the system now in ordinary use, the light car would receive the same pressure as the heavy car, giving an excessive strain on the trail car brake rigging. This valve is simple in construction and is not sensitive to the foreign matter with which the air used in the air-brake system on street railway cars is generally charged.

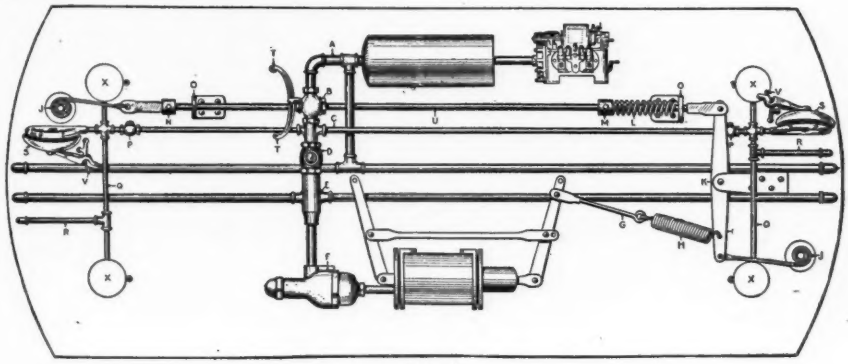


FIG. 4.

Another advantage claimed for this reducing valve is that it can be placed close to the brake-cylinder where it will register quickly and not be subjected to constant pressure. The use of this valve, it is claimed, also overcomes, to a large degree, the variation in air-governor pressure while the braking pressure remains at the pressure at which the leverage is figured.

Fig. 3 shows the air system from where the air is compressed to where it is utilized as well as the simplicity of the apparatus.

Fig. 4 shows how the conductor has the same control of the car as the motorman, as indicated in the pipe line from *A* to *F*. It will also be seen how the valve *B* can be operated from either end of the car by a cord attached to a lever *T*, which causes the air to flow through the pipe line *C* to the gong *S* and to the sand-boxes *X*, through the valve *E*, which shuts off the train line and continues through the bypass in through the reducing valve *F*, thence into the brake cylinder, thereby causing the brake to apply. When the brake is applied this causes the operation of an additional fulcrum arm *K* by means of connections indicated by rods *G* and *H*. The movement of the fulcrum arm unwinds the controller shaft *J*, thus turning off the power. A spring is employed to bring the fulcrum arm back to its normal position as indicated at *L*. The rod connected to the fulcrum arm operating the other end of the car is indicated at *U*. Check valves *P* are provided for the purpose of preventing the gong and sand from being operated on the rear end of the car when the motorman is operating the car from the front end. The usual means provided to sound the gong is indicated at *V*.—*Electric Traction.*

BOILING POINTS OF METALS

The boiling points of various metals have been determined by H. C. Greenwood, by means of an optical pyrometer, at the time when vaporization became sufficiently vigorous to project drops of metal from the surface. These boiling points (Centigrade) at atmospheric pressure are as follows: Antimony, 1420; Bismuth, 1440; Lead, 1525; Aluminum, 1800; Manganese 1900; Silver, 1955; Chromium, 2200; Tin, 2275; Copper, 2310; Iron, 2450.

THE PNEUMATIC HAMMER

You can hear my sharp staccato as I play an obligato
On the girders of a structure that is forty stories high,
While the crowd below is gawking at the iron workers walking
On a slender swaying "I" beam sort of tethered to the sky;
They're the song and I'm the chorus, and we have our job before us
As we tie the steel together with the rivets red and hot,
And the sparks they hiss and spatter as I clatter, clatter, clatter!
For I like to have it noticed that I'm Johnny on the Spot!

Then I'm numbered with the toilers who are turning out the boilers
And you'll find my masterpieces on the land and on the sea,
Keeping railroad trains in motion, driving liners on the ocean,
Or supplying the compressors with the force they give to ME!
Set a task, I sure attack it with the maximum of racket,
I'm no shy retiring worker, I am talkative and loud,
And I batter and I chatter as the sparks go spatter, spatter
And I love the busy city and the noises and the crowd!

Where they build the ships for battle you can hear my airy prattle
As I hammer on the framework of the warriors of the deep,
And where bridges span the river I can keep your nerves a-quiver
With my everlasting clamor which would never let you sleep.
I'm the young tradition shaker, I'm the blatant empire maker
I'm the prophet of to-morrow and the builder of to-day,
Sloth and ancient doubt I shatter as I clatter, clatter, clatter
In a song of hope and progress and a yell of "clear the way!"

Berton Braley in Technical World.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

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CONTENTS

Compressed Air in Foundry Practice.... 6667
Compressing Natural Gas 6673
Novel Vacuum Pump 6675
Compressed Air Storage in Rock 6677
Soapsuds Lubricator for Compressor..... 6678
Air-Granulation of Molten Slag 6678
Compressed Air Hoisting at Butte..... 6680
New Concrete Blower 6684
Humidification of Mine Air 6685
Johnson Air Brake System 6686
Boiling Points of Metals 6688
The Pneumatic Hammer 6688
Making Good 6689
Still a Big Supply of Nitrates 6690
Negligent Compressed Air Practice 6690
For Compressed Air Auto Starters 6691
Compressed Air at Panama 6693
Compressed Air Displaces Steam for Oil Burners 6694
Notes 6694
Patents 6695

MAKING GOOD

The present is the age of mechanical appliances intended to replace the labor of man. Formerly the principal reason for using machinery instead of human hands was because of the greater productive capacity of the power-driven apparatus, and this is still the natural incentive to devise so-called labor-saving machinery. With the developing use of mechanical devices for doing work, however, there have appeared a number of other reasons for their extending use, reasons which, when followed to their legitimate conclusions, cannot fail to have an important influence upon methods of administration and management.

Thus it is well understood that heavy and brutalizing labor, such as lifting heavy burdens, violent exertion under exposure to high heat, as in stoking boilers or operating metallurgical furnaces, drilling and cutting rock in different positions, and similar heavy physical labor, is well replaced by mechanical appliances, even if no other advantage resulted. The men who formerly did such work are far better employed in guiding and directing the power-driven machinery than in straining their muscles beyond reasonable limits.

Again, in the development of repetitive processes the machine relieves the man from the continual and monotonous operations which fatigue the hand and make little or no demand upon the mind, setting the operator free to control and manage a number of tools, upon which he directs his head, using his hands in a reasonable and legitimate manner.

These are but a few examples of the manner in which the engineer is raising the position of the workman from that of a machine himself to that of a director of machinery, and to this industrial development much of the progress of the world to-day is due.

When, however, a machine is so designed as to take the place of a man, or of many men, the inanimate apparatus itself is also placed upon a different plane, and partakes, so to speak, of a portion of the responsibility of the individuals which it replaces. If a man failed to do his work properly, he was held responsible for the consequences, and the rank and position of the skilled workman depended very largely upon his record and reputation. This is still the case, in an increasing degree, of the man; but it has also been largely placed

upon the machine, so that apparatus made by builders of high reputation partakes of the standing of the firms by whom it is built. As a natural consequence of this responsibility, the reputation of the manufacturer is dependent upon the performance of machinery bearing his name, thus builder and tool have a status to be maintained.

Nearly every man who has built up a reputation for himself and his work has done so by actual performance, by "making good," and when any question arises as to his capacity for any undertaking placed in his hands he is able to produce his credentials and stand upon his record.

The machine which, to a large extent, is taking the place of the man, must also be able to produce its credentials and show its record; and when this can be done it is placed in much the same position as the skilled workman who has his past work to witness to his ability and capacity. The new machine is in like manner comparable to the new man; it may be most excellent, even better than the equipment which has been in use for years, but it has its record to make and its credentials yet to acquire.

Thus, while methods and devices change, the fundamental principles beneath them reappear in forms which may readily be perceived by the observant engineer and manufacturer, guiding him and aiding him in attaining best results by enabling him to bring to his service both men and apparatus of the highest class.

STILL A BIG SUPPLY OF NITRATES

In our September issue readers were editorially urged not to worry about the atmosphere because of the abstraction from it of a little nitrogen for the manufacture of fertilizers. Now comes William S. Myers, official delegate of the Chilean government to the International Congress of Applied Chemistry, and head of the Nitrate Propaganda in this country, who assures us that the current statements regarding the exhaustion of the world's supply of nitrogen are uncalled for. He says:

First of all, there is a vast amount of unsurveyed nitrate ground on the Chilean pampas that is known to contain immense quantities of nitrate of soda. Second, grounds already surveyed still contain enormous quantities of nitrate. There are probably in round numbers, 1,000,000,000 tons of nitrate in the deposits of Chile, and, without doubt, large supplies also exist on lands now but incompletely prospected. The surveyed and certified tonnage opened up at the present time ready for extracting is fully 250,000,000 tons.

The probable life of the surveyed deposits is at least 400 years, even allowing for a steadily increasing annual rate of consumption. Moreover, there remains the interesting question as to whether by the end of the ensuing century we may not find that nature has manufactured an immense additional amount of Chilean nitrate for the uses of the world.

Sir William Crookes' prophecy that the world would starve as soon as the Chilean nitrate supplies were exhausted has for some years led the chemical public to believe that a wheat famine was in sight, but that time is so far distant that no one living to-day need have misgivings on the subject.

NEGLIGENT COMPRESSED AIR PRACTICE

At a meeting of mining engineers recently held at Edinburgh Mr. Sam. Mavor spoke of compressed air in British coal mines as follows:

I am at present conducting an investigation into the use of compressed air in underground work, and in the course of this investigation some surprising results have emerged. Your compressed-air pumps, compressed-air haulages, and compressed-air coal-cutters, are nearly all inefficient, not only absolutely inefficient, but inefficient relatively to the efficiency which might be obtained from this class of plant. The ultimate responsibility for this state of affairs rests upon the manager. In the course of the investigation to which I refer it has emerged that not unusually the proportion of leakage of compressed air is from 20 to 30 per cent. of the total amount of the air compressed. In some cases the proportion of loss by leakage has been considerably over 30 per cent. of the total volume of air compressed. Many managers have been reluctant to believe that they are doing so badly, but if there is any colliery manager who is using compressed air for general power service underground who thinks he is obtaining any such efficiency as 20 per cent. I am quite prepared, at his own colliery to demonstrate his error.

There is no other type of plant so liable to

deteriorate in respect of efficiency as that operated by compressed air. If there is plenty of power on the surface, underground losses develop and increase, but so long as the required work is done somehow, the losses do not bite anybody, and they pass unnoticed. In the days of underground steam pipes, when leaky steam joints made a roadway intolerable, the joints were repaired, but with compressed air there is no such compelling inconvenience.

One of the last things one finds underground is a pressure gauge, yet no instrument is more easily applied, nor could any provide a more direct and emphatic check upon one of the principal sources of low efficiency of the compressed-air system. It is a simple and almost incredible fact that at the majority of collieries where compressed air is used a pressure gauge is never seen underground. This is true not only of small collieries, but of many large ones. It is not unusual, on the contrary it is quite usual, to find that half the total pressure to which the air is compressed is lost in the trailing hose, valves, and piping in the immediate neighbourhood of coal-cutters. Immense sacrifice of efficiency in compressed-air coal-cutters is due to hose, valves, and branch piping being much smaller than they ought to be. Low efficiency here involves not only loss of power, but inefficient use of labour, because two shifts of men are often required to cut a distance that with proper appliances could be cut in a single shift. No one who has not had opportunities of investigating present-day conditions as to the use of compressed air, has any conception of the extent of the general preventable extravagance of power and labour resulting from lack of competent supervision of in-bye details.

COMPRESSED AIR AUTO STARTERS

The following we condense from a recent issue of *Internal Combustion Engineering*, London.

The time is rapidly approaching when every car will have some kind of self-starting apparatus installed as a standard fitting, the buying public are demanding it, and designers ought therefore to consider which of the many systems they will have. Though the use of compressed air is regarded by some as inferior to other systems, it is undoubtedly as effective in starting the motor, and has the advantage of being of use for other purposes than that for which it is primarily installed.

The most favoured installation comprises the following: An air pump, or compressor; a cylindrical steel tank for storing the compressed air; a distributor for passing the air to the engine cylinders in proper sequence, and a starting valve, situated in a handy position for the driver. The pressure to which the air is to be pumped and maintained is first decided, and this is governed largely by the size of tank it is permissible or desirable to carry. The usual practice is a tank of about 800 to 1,000 cubic inches capacity, with an air pressure of from 300 to 400 pounds per square inch. This pressure is, of course, much in excess of that actually necessary to start the motor, especially if it be a six-cylinder, 100 pounds per square inch being in most cases ample; but, as above implied, if a lower pressure were used a larger tank would have to be carried. A lower pressure is to be recommended, as it has three points of advantage at least over the high, namely:—

It is not so likely to blow the joints and connections.

The pressure on the pump bearings and distributor disc (where this type of distributor is used) is reduced, and consequently the wear also.

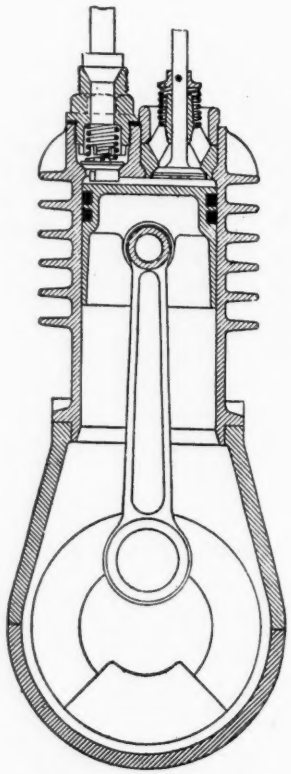
Upon the compressed air entering the engine cylinders it expands, and consequently its temperature drops very rapidly. The higher the pressure of the air entering the cylinder, the lower will be its final temperature after expansion, and the greater its chilling effect on the interior of the cylinder.

This last is considered by some to have a detrimental effect upon the motor, and although it is of little consequence when the motor is started from cold, it certainly is undesirable in cases where the engine is stopped and started frequently during a run, as the first gas charge entering the cylinder encounters the chilled cylinder walls, and in all probability some few gas charges pass through the cylinders before an explosion takes place. The effect of this chilling, of course, vanishes as soon as an explosion has taken place and the motor is running on its own fuel.

The air pressure having been decided upon, the design for the various components can be made out. It is rather surprising to note here that those manufacturers who have al-

ready fitted a starting system similar to that here described, have almost invariably distributed it over the entire chassis, and the control (in the case of those systems which provide means for cutting out the air pump when the pressure in the tank is attained) and piping arrangements have consequently been complicated, heavy and expensive. In some cases both the air pump and the distributor have been situated on the engine, the pump being driven from the camshaft direct, while the distributor is usually driven by skew gears from the camshaft situated about the centre or the opposite end of the engine. Others have taken the drive for the compressor from the clutch shaft, thus necessitating its attachment to either the side member of the chassis frame or the gearbox. In this case the distributor usually takes its drive from the front end of the camshaft direct. In designing a starter of this type to suit an existing car, these arrangements could not easily be avoided, but in cases where the starter has been designed with the car, it is difficult to see why these arrangements have been adopted.

Considering first the compressor it is certainly desirable to arrange that it shall be thrown out of operation as soon as the desired pressure of air in the reservoir is reached. Some designs provide means whereby the compressor, when the final pressure is reached, no longer delivers air to the reservoir, but expels its charge into the atmosphere again, the inlet valve being held open, usually mechanically. Another method is to have the clearance space at the end of the cylinder such that, with the valves closed and a charge of air compressed with the piston at the end of its stroke, the pressure inside the cylinder shall be equal to the final pressure in the reservoir. In this case, when the pressure is attained in the reservoir, the pressures on each side of the delivery valve are equal, and consequently it will not open until the pressure in the reservoir drops, and the air in the cylinder is undergoing compression and expansion alternately. The first method is likely to be noisy, and both are adding greatly to the wear. So that, as it is exceedingly desirable that the piston and rings, at any rate, remain tight for as long a period as possible, it is evident that it is well worth while to provide means for cutting out the compressor altogether, especially as it can be done at little cost.



AIR COMPRESSOR FOR AUTO.

A typical design of compressor is shown in the cut, and needs no description. The usual size is about 1¾ in. bore by 1¾ in. stroke, two rings on the piston have proved satisfactory, the valves, inlet and delivery are usually in the head of the cylinder and of fair size, the inlet valve for a pump of the above size being about $^{11}/_{16}$ in. outside diameter. In a few instances the inlet valve has been replaced by holes drilled through the cylinder wall in such a position that the piston uncovers them when nearing the bottom end of its stroke, thereby admitting the fresh charge. When determining the clearance volume of one of these pumps it must be remembered that their efficiency is very low, seldom exceeding 45 per cent. Heat losses, losses due to leakage, and incomplete cylinder filling account for this. It seems that the heat losses are likely to remain, as it is universal practice up to the present to rely on air cooling, and it is

a question as to whether anything else is worth considering in this case. Leakage, of course, depends greatly on workmanship, and with this type of starting system workmanship is of great importance all through.

Now we come to incomplete cylinder filling, or volumetric efficiency, and this accounts for over 30 per cent. of the total losses; the automatic inlet valve is to blame for this to a large extent, as it sets the limit to the initial pressure in the cylinder before compression takes place.

Take for example a pump of the size mentioned above, 1¾ in. by 1¾ in. Inlet valve $^{11}/_{16}$ in. outside diameter, spring pressure 1 lb. Delivery valve $^{9}/_{16}$ in. outside diameter, spring pressure 1 lb. Clearance volume 5½ per cent. of the total volume of the cylinder.

The volume swept by the piston is 4.2 cubic inches. Clearance volume equals .245 cubic inches. Taking the formula for the compression of air, Adiabatic,

$$\frac{(V)^{1.41}}{(v)} \times A = \text{Terminal pressure.}$$

Where V = total volume, v = clearance volume, and A is atmospheric pressure, about 14.7 lbs., we have:

$$\left(\frac{4.445}{.245}\right)^{1.41} \times 14.7 = 886 \text{ lbs.}$$

A compressor of approximately the above dimensions gave a pressure in the reservoir of 350 lbs., so that the efficiency was only about 40 per cent.

To get a reasonable idea as to what the initial pressure was we have to find at what pressure, inside the cylinder, the inlet valve will open. Assume that the pressure in the clearance space is 14.7 lbs., and that the pressure on the valve due to the spring is equal to 2.7 lbs. per square inch, then the total pressure acting from inside the cylinder upon the valve is 17.4 lbs. per square inch of valve area, while the pressure acting from the outside is 14.7 lbs. It is evident from this that before the valve opens there must be a difference in the air pressure on the cylinder side of the valve below that of the atmosphere of 2.7 lbs. Of course the actual initial pressure would be slightly less than this 12 lbs. owing to the outer air pressure having to overcome the inertia of the valve spring, so the initial pressure can be safely taken as being not more than 11.7 lbs., thus accounting for a loss of 20 per cent. of the volumetric efficiency. The remaining 40 per cent. is for the most part due to heat losses.

Whether the pump should have more than one cylinder is largely a matter of choice. A two-cylinder pump can be made well balanced and raises the pressure quickly. With regard to throwing the compressor out of gear, a favored arrangement is to have a small dog clutch to engage with either the driven gear or the pump spindle as the case may be. It is not a difficult matter to design a reliable automatic device to do the work, and as compressed air is at hand why not use it?

Considering what may be done to put this type of self-starter ahead of its present rivals, it is certain that the most serious charge laid against it is the fact that, should a four cylinder motor stop with its cranks at dead center, it is impossible to start with compressed air. The mistake seems to be in allowing the air to enter the engine at all. It does not appear to be at all impossible to design the air pump in such a way that for starting purposes it operates an air motor turning the engine over through gearing.

COMPRESSED AIR AT PANAMA

By Fred H. Colvin.

One of the largest air-compressor plants in the world is that which supplies compressed air for the work on the Panama Canal. Of the four separate stations, the one at Empire is the largest and the one at Balboa the smallest. The other two are at Las Cascadas and Rio Grande.

The air compressors at Las Cascadas, Empire and Rio Grande deliver their entire output into a 10-in. main, 14 miles long, from which it is drawn off by smaller subsidiary mains to the air drills and other machinery at various points along the canal. The great majority of the air is used in and around Culebra Cut.

The plant at Balboa comprises two Laidlaw-Dunn-Gordon compressors, each capable of delivering 2,200 cu. ft. of air into a main four miles long. The two plants thus have 18 miles of air-compressor mains, which is believed to be the longest in existence.

The other three plants contain six Laidlaw-Dunn-Gordon compressors of 2,500 cu.ft. capacity each and eight Ingersoll-Rand compressors of the same capacity. The Empire plant

has an average total monthly output of over 400,000,000 cu.ft. of free air at 70 deg. F. The largest total monthly output for all the plants according to the last report, was 794,357,608 cu.ft., while the average cost of it for the year was 3.24c. per 1,000 cu.ft.

The maintenance of the 14 miles of 10-in. main entails a great deal of trouble, due to the changing character of the soil and the constant jarring of the earth from the daily blasts in Culebra Cut. In 1911, 6300 ft. of the main had to be taken up and relaid, due to its proximity to two slides along the banks of the canal. Patroling these pipe lines has been found advantageous and a good investment in view of the saving effected in the amount of air lost through strained and leaking joints.

A very close account of the cost of compressing the air is kept month by month, the charges being divided into labor and materials for operating the plants, their maintenance, and any extensions which may be necessary.

From oil-fired boilers an evaporation of 14.53 lb. of water per lb. of oil is obtained. Various tests showed that from 157½ to 168 gal. of oil were equivalent to 1 ton of coal.

The lubricating oil is very carefully accounted for, the performance being given in revolutions of the compressors per gallon. The plant at Rio Grande shows 174,000 revolutions per gallon of valve oil, 177,760 revolutions per gallon of engine oil and 461,065 revolutions per gallon of air cylinder oil, while at the Empire plant the last item is 836,875, or nearly double. The output in compressed air per barrel of fuel oil runs remarkably uniform, the lowest being 42,180 cu.ft. of free air per barrel of fuel oil at the Rio Grande plant and 43,196 cu.ft. for the plant at Las Cascadas.—*Power.*

COMPRESSED AIR DISPLACES STEAM FOR OIL BURNING FURNACES

V. S. Nazaroff, engineer of the Transcaucasian Railroads, Russia, has substituted compressed air for steam in the atomization of liquid fuel, his arrangement as applied to a locomotive being shown in the cut, where *C* is the compressed air tank, *b* fuel pipe, and *B* fuel tank, the fuel used being *mazout,* or residues of rock-oil. The disadvantages which were found in the use of steam for the atomization of liquid fuel consisted in trouble and loss of time in starting; explosions in the furnace produced by the condensation of some of the derivatives of the fuel used forming highly explosive mixtures, and not infrequently burning the firemen; dissociation of steam in the hottest part of the furnace with the formation of a gaseous mixture which on recombining produced noises like pistol shots. All this is said to be eliminated when compressed air is used instead of steam, and further an economy of 38 per cent. in the consumption of fuel is secured.—*Foreign Review A. S. M. E. Journal.*

NOTES

The first military airman killed in actual war was brought crashing to the ground with his aeroplane by shrapnel shells while flying over Adrianople. His name was Popoff, and he had been an aviation instructor in the Russian army.

A standard test code for performance tests of compressors, blowers and exhausters, has been formulated by a committee of the Verein deutscher Ingenieure. It is reported by Prof. L. Prandtl and R. Goetze in the "Zeitschrift des Vereines deutscher Ingenieure."

The real reason why construction work has been suspended on the extension of the Grand Trunk Ry. to Providence, R. I., has at last been discovered. It appears that the draftsmen who are plotting the surveys have not yet been able to spell Lake Chaubunagungamaug. A Welsh draftsman has been cabled for.—*Engineering News.*

A fire occurred in the private automatic telephone switchboard in the Baldwin locomotive works, Philadelphia, caused by a short circuit in the automatic safety device, termed the heat coil. Nothing else being handy, a resourceful person seized a hose connected with the compressed air system and *blew out the fire.*

Breathing can usually be restored after an electric shock within an hour, says *Coal Age.* Keep up artificial breathing for this length of time at least. After breathing starts, begin to restore the circulation by rubbing the limbs briskly in the direction of the heart and under the covers with which the patient has been previously covered.

A company, with $2,700,000 fully subscribed capital, has been founded in Christiania to produce sulphate of ammonia from the atmosphere after the method of an Austrian engineer, Dr. Serpek. Construction of the mill will commence immediately at Arendal, operation to start in the Autumn of 1914. At first 10,000 hydroelectric horsepower will be used, to be increased later to 25,000. The annual output is calculated to exceed 40,000 tons of sulphate of ammonia.

To John Mabbs, agent of the Isle Royale mine, in the Lake Superior district, belongs the credit for having introduced the power drill to the mining world, says A. H. Meuche, in a recent publication of the Michigan Geological Survey. Mr. Mabbs induced Mr. Rand, who was manufacturing a heavy drill for tunnel work, to make a light and portable one for mine use. With some old engines at the mine he made a compressor and with cast-iron pipe conducted his compressed air underground.

Dr. Marie Stopes of London has been interested for nine years in the study of fossil botany, and has in preparation a book that is expected to throw new light on the subject of coal geology. She has visited the interiors of mines in all parts of the world, including a mine in one of the Japanese islands extending out under the sea. She says coal can not be less than twenty million years old, and that the first plants which entered into its formation were twice as old as that.

Johannesburg is the centre of the gold-mining industry, yet it doesn't seem a bit ashamed of itself. It is a very large and very dusty town, and is principally inhabited by people who are trying to escape from it. Every month something like £1,236,745 worth of gold is worked out of the mines round Johannesburg, but it is not all profit. £1,000,000 may be described as working costs, £236,000 goes to the Government in one way or another, £700 is transferred to the reserve, and the odd £45 is available for distribution among European shareholders.—*Punch.*

Gas from a stalled locomotive in the Northern Pacific Ry. tunnel near Ellensburg, Wash., caused the death of one of the train crew and injury to a number of others, on Nov. 6.

Coal-mining machinery improvements resulted in an increased output in the United States last year of coal mined with machines of 4 million tons over 1910, whereas there was a total decreased output of 11 1-3 million tons.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sendingn five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

NOVEMBER 5.

1,043,080. MOISTURE-SUPPLYING DEVICE FOR CARBURATED AIR. OMER DUIS, Streator, Ill.

1,043,115. FLUID-METER. JOHN W. LEDOUX, Swarthmore, Pa.

1,043,129. BOTTLE-BLOWING MACHINE. JAMES MURPHY, London, England.

1,043,220. PNEUMATIC PIANO-PLAYER. CHARLES FREBORG, Kankakee, Ill.

1,043,302. ROCK-DRILL. HENRY DEITZ, Denver, Col.

1,043,319. PUMP. OSCAR W. JOHNSON, Rockford, Ill.

1. The combination of a base, a water-cylinder supported thereby, an air-cylinder located below, parallel to said water-cylinder and supported by the base, pistons for the cylinders, a double-faced rack, a connection between the rack and water cylinder piston, a toothed-segment engaging one of said rack faces, a connection between the segment and air-cylinder piston, and means for reciprocating said rack.

1,043,399. STARTING DEVICE FOR EXPLOSIVE-ENGINES. MILTON E. COLE, Akron, Ohio.

1. A starting device for explosive engines comprising a cylinder, a piston therein adapted to be operated by a *fluid under pressure*, a piston-rod carried by said piston, said piston-rod provided with rack-teeth, a rotatable shaft adapted to be temporarily coupled with a suitable portion of an engine to be started and adapted to be longitudinally shifted into engagement therewith by a fluid under pressure, a gear loosely rotatable on said shaft, a ratchet-wheel fixedly mounted on said shaft, a pawl carried by said gear adapted to engage said ratchet-wheel when said gear is operated in one direction for rotating said shaft, and resilient means for withdrawing said shaft from engagement with said engine portion.

1,043,411. FLOATING DRY-DOCK. GUNNER C. ENGSTRAND, Tompkinsville, N. Y.

1,043,457. SHOCK-ABSORBING SUPPORT FOR PNEUMATIC HAMMERS. REINHOLD A. NORLING, Aurora, Ill.

1,043,464. COMBINED HIGH AND LOW PRESSURE GAS-LAMP. AMANDUS C. ROESSLER, Mineola, and WILLIAM A. ARMINGTON, New York, N. Y.

1. In combination, a burner, converging gas and air passages for conducting gas, and *air under pressure* to said burner, a direct gas passage disposed between the converging passages, and means controlling flow through either of the gas passages.

1,043,529. PNEUMATIC ENGINE OR TOOL. JOSEPH D. MACDONALD, Butte, Mont.

1,043,534. AIR PISTOL OR GUN. GEORGE NORMAN, Birmingham, England.

1,043,593. PNEUMATIC ACTION FOR PIPE-ORGANS. CLARENCE K. HECKMAN, Hagerstown, Md.

1,043,657. AIR-GUN. WALTER H. ALBRIGHT, Bellevue, Ohio.

1,043,677. PNEUMATIC CUSHION FOR VEHICLES. JOHN OWEN DAVIS, Pawnee, Okla.

1,043,704. COMBINATION ALARM DEVICE. MILLER REESE HUTCHISON, New York, N. Y.

NOVEMBER 12.

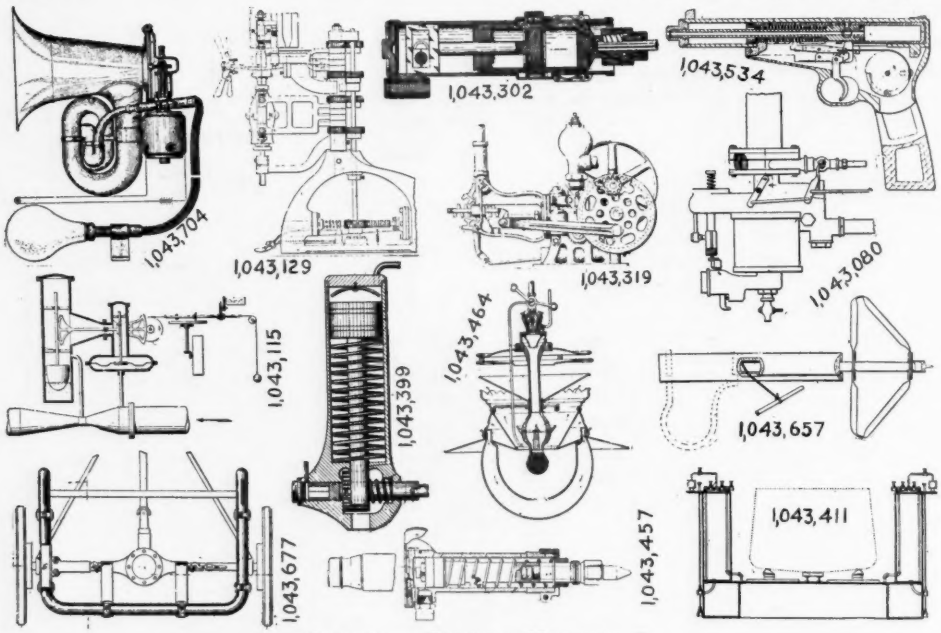
1,043,803. AIR-BRAKE VALVE. JOHN CHUDLEIGH, Haberfield, and JOHN WILSON FELL, Sydney, New South Wales, Australia.

1,043,836. PARACHUTE APPARATUS. WILLIAM A. HODGE, Milford, Conn.

1. A device of the character described, comprising a *compressed air reservoir* adapted to be secured to the person of the aeronaut, a valve controlled nozzle for said reservoir, a parachute whose inner face is secured to the upper end of said nozzle, means for resiliently inclosing the parachute and nozzle in collapsed condition, and means controlled by the aeronaut for releasing the parachute and opening said valve.

1,043,880. PNEUMATIC TORPEDO. MAX THOMSEN, Chicago, Ill.

1,044,015. PNEUMATIC INSOLE AND ARCH-SUPPORT. MATTHEW BYRNE, San Francisco, Cal.



PNEUMATIC PATENTS, NOVEMBER 5.

1,044,031. METHOD OF CAUSING ARTIFICIAL RESPIRATION. JOHANN HEINRICH DRAGER, Lubeck, Germany.

1. The method of producing artificial respiration which comprises filling the lungs from a suitable source of *compressed gas* until a back pressure of said gas sets in, when the lungs have been filled and diverting the current of gas by said pressure to cause it to move in a direction away from the mouth of the human being so as to produce a suction to discharge the air from the lungs.

1,044,175. CONVERSION OF COAL-TAR, PETROLEUM RESIDUES, CREOSOTE AND SCHIST OILS, AND THE LIKE, INTO PITCH. HENRI HENNEBUTTE, Paris, France.

3. The process of transforming a mixture of tar of high boiling point and oil into pitch consisting in directing air through several columns, in the first of which practically all of the oxygen is removed, and then producing transformation, the air current freed of oxygen carrying vapors which it deposits in the second column.

1,044,197. VALVE-OPERATING MECHANISM FOR MOTORS. JOHN M. LARSON, Chicago, Ill.

1. In a motor having a cylinder and a valve to control the flow of fluid into and out of the said cylinder, a channel for the flow of *pressure fluid* to said valve, means for operating said valve comprising a rotatable shaft, means for causing the action of said piston to partially rotate said shaft, and a relatively smaller auxiliary piston for further rotating said shaft, and a constantly open connection between said auxiliary cylinder and said source of pressure fluid channel.

1,044,263. PNEUMATIC HAMMER. HENRY SCHUMACHER, Denver, Col.

1,044,275. VACUUM CLEANING DEVICE FOR ANIMALS. JAMES J. SLEVIN, New York, N. Y.

1,044,289. BRAKE FOR AUTOMOBILES. JOHN D. TAYLOR, Edgewood Park, Pa.

1. Means for converting an internal combustion engine into an air pump for braking purposes, comprising in combination means for stopping the supply of fuel to the engine for connecting the fuel inlet of the engine with the atmosphere, and means for permitting a free exhaust from the engine at the end portion of a compression stroke; substantially as described.

1,044,337. ROCK-DRILL. THOMAS J. BARBRE and JAMES G. TREFZ, Denver, Col.

1,044,367. INHALER. GEORGE A. EVANS, New York, N. Y.

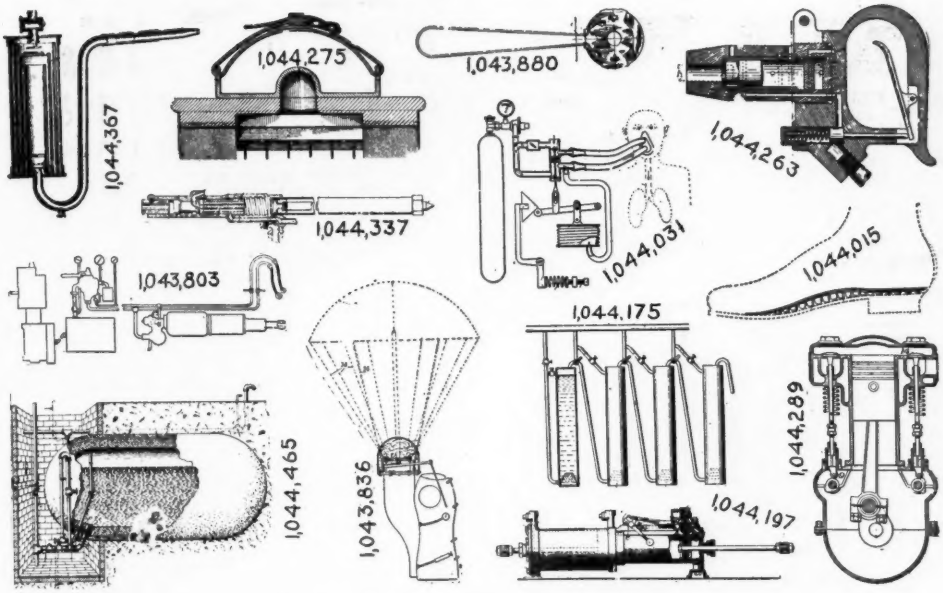
1,044,368. FERMENTATION PROCESS FOR THE PRODUCTION OF ACETONE AND HIGHER ALCOHOLS FROM STARCH, SUGARS, AND OTHER CARBO-HYDRATE MATERIAL. AUGUSTE FERNBACH, Paris, France, and EDWARD HALFORD STRANGE, Staple Inn, London, England.

1. The process of obtaining acetone and higher alcohols which consists in mixing carbohydrate matter with water, sterilizing the mixture, adding a ferment of the type of the butylic bacillus of Fritz and then subjecting the mixture to fermentation *in the absence of air* and leading off and condensing the vapors as they are formed.

1,044,444. FLUID-PRESSURE REGULATOR. JOHN ELOV ENGLESSON, Karlskrona, Sweden.

1,044,465. AIR-PRESSURE RESERVOIR. BERT L. MILLS, Hastings, Neb.

1,044,467. MANUFACTURE OF BREAD. GEORGE LUNT, Formby, England.

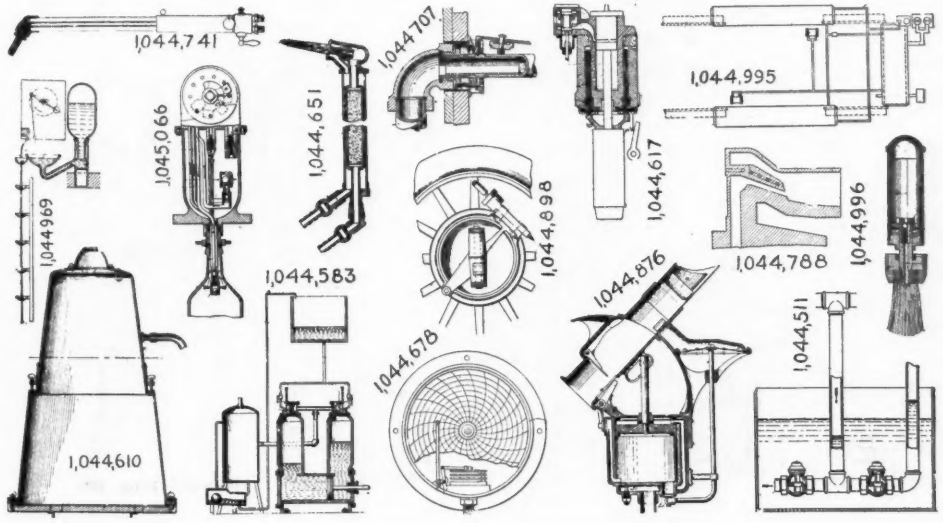


PNEUMATIC PATENTS, NOVEMBR 12.

3. A process for the treatment of dough consisting in allowing the dough to rest after complete mixing of its ingredients for a part of its normal period of fermentation and subdividing it in a free-oxygen-containing gaseous atmosphere *under pressure* and recombining the dough particles while still in this gaseous atmosphere.

NOVEMBER 19.

1,044,511. PUMP FOR EXPLOSIVE GAS. JOHN C. FOUNTAIN, London, Ontario, Canada.
1,044,583. AIR-COMPRESSOR. WILSON SELAKOSKY, White Haven, Pa.
1,044,610. VACUUM APPARATUS. ALFRED WENDER, St. Louis, Mo.
1,044,613. DUST SEPARATOR AND FILTERING MECHANISM FOR VACUUM-CLEANERS. THEODORE WIEDEMANN and JOSEPH H. TEMPLIN, Philadelphia, Pa.
1,044,617. HAMMER-PRESS. EDWARD H. WRAY, Philadelphia, and LOUIS M. PYLE, Bryn Mawr, Pa.
1,044,636. PNEUMATIC PIANO-PLAYER. CHARLES FREBORG, Kankakee, Ill.
1,044,651. BLOWPIPE. JOHN HARRIS, Cleveland, Ohio.
1,044,653. APPARATUS FOR STERILIZING WATER. SIEGFRIED HELD, Chicago, Ill.
1,044,678. RECORDING LOW-PRESSURE GAGE. COLEMAN J. MANNING, Medford, Mass.
1,044,707. CLOSURE FOR AIR-SUCTION



PNEUMATIC PATENTS, NOVEMBER 19.

PIPES. WILLIAM S. SUTTON, Rockford, Ill.

1,044,741. CUTTING-TORCH. WORTHY C. BUCKNAM, Jersey City, N. J.

1,044,788. AIR-COOLED OPEN-HEARTH FURNACE. HENRY KNOTH, Monterey, Mexico.

1,044,876. PNEUMATIC-DESPATCH-TUBE APPARATUS. EDMOND A. FORDYCE, Boston, Mass.

1,044,898. FLUID-PRESSURE-CONTROLLING SYSTEM FOR MOTOR-VEHICLES. ALEXANDER GRANT MCGREGOR, Salt Lake City, Utah.

1,044,969. APPARATUS FOR TESTING AIR OR OTHER GASES. MAX ARNDT, Aix-la-Chapelle, Germany.

1,044,995. AIR-MOTOR. WILLIAM CREELY, Bay City, Mich.

1,044,996. BRUSH. WILLIAM CUTHBERTSON, Chicago, Ill.

1,045,205. TRANSFER-TUBE SYSTEM. JOHN F. SKIRROW, East Orange, N. J.

1,045,217. TREE-SPRAYER. FRANK M. THOMAS, Muncie, Ind.

1,045,226. PNEUMATIC ACTION FOR SINGLE-SYSTEM MUSICAL INSTRUMENTS. PETER WELIN, Worcester, Mass.

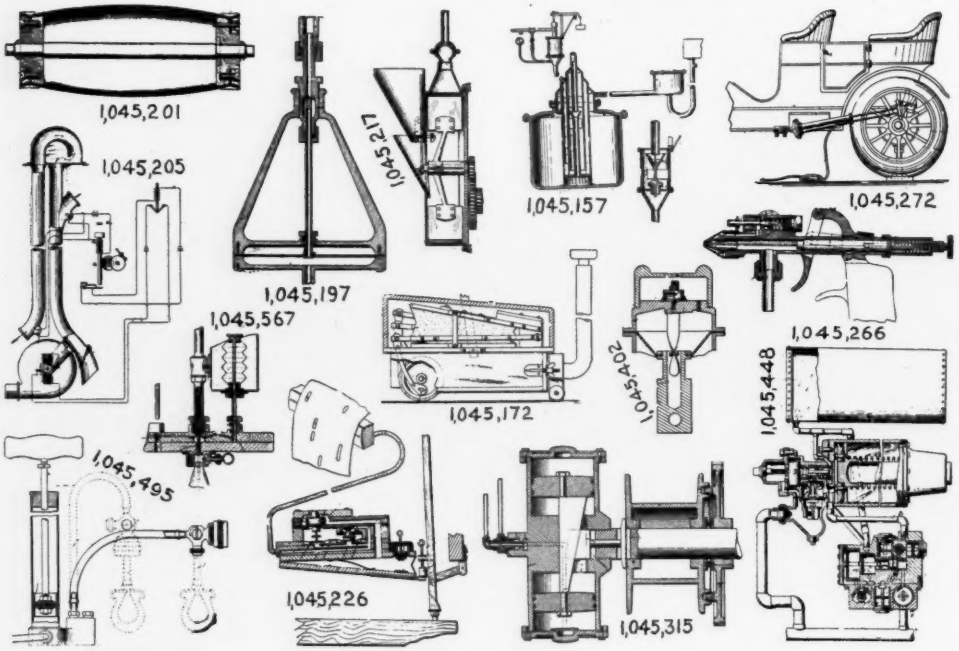
1,045,260. EMERGENCY OPERATING DEVICE FOR AIR-BRAKES. GEORGE L. COLLINS, Hickman, Ky.

1,045,266. AIR-BRUSH. THOMAS A. DE VILBISS, Toledo, Ohio.

1,045,272. MEANS FOR ATTACHING AIR-PUMPS TO AUTOMOBILES. EDWIN W. FISHBURN, Denver, Col.

1,045,315. FLUID-ACTUATED CLUTCH. FRED C. MOTT, Satsop, Wash.

1,045,373. HIGH-POWER AIR-RIFLE. EDGAR P. COOK, Granville, Ohio.



PNEUMATIC PATENTS, NOVEMBER 26.

1. In a brush the combination with a hollow cylindrical handle adapted to contain a liquid, of a piston, cup valve and piston rod having a duct therethrough, an air chamber, and means for operating said piston rod.

1,045,066. METHOD OF AERATING LIQUIDS. LUDWIG NEUMAYER, Strassburg, Germany.

The herein described method of aerating liquid, consisting in supplying gas under pressure to a column of confined liquid, permitting a portion of the gas to escape from the column of liquid and subsequently confining the escaping gas, and finally subjecting the column of liquid to an additional charge of gas and forcing the aerated liquid in sprays to the confined gas previously expelled from the column of liquid.

NOVEMBER 26.

1,045,157. AUTOMATIC CHEMICAL AIR-LIFT. AUGUST LONG, Bayonne, N. J.

1,045,172. PNEUMATIC PUMP. THEODORE O. OSTERHOLM, Worcester, Mass.

1,045,197. PRESSURE-REGULATOR. PETER J. SCHULER, New Hampton, Iowa.

1,045,201. PNEUMATIC ROLL. CHARLES GUY SHOOP, Beloit, Wis.

1,045,402. PULSATOR FOR PNEUMATIC MILKING. CHRISTIAN VALDEMAR HENRICHSEN, Copenhagen, Denmark.

1,045,448. AIR-BRAKE APPLIANCE. WALTER A. SKINNER, Moberly, and THOMAS F. CAIN, Montgomery City, Mo.

1,045,462. LUBRICATOR FOR AIR-PUMPS. WALTER V. TURNER, Edgewood, Pa.

1,045,495. TIRE-INFLATING PUMP. HENRY K. AUSTIN, Reading, Mass.

1,045,542. X-RAY-TUBE VACUUM-CONTROLLER. CERAN GAVEAU, New York City.

1,045,567. MACHINE FOR BOTTLING LIQUIDS UNDER PRESSURE. JOHANNES KARLSSON LANNMARK, Stockholm, Sweden.

1. In a machine for bottling liquids under pressure, the combination of a receiver for the liquid, a compressible air receiver placed inside and separated from the said receiver for the liquid and connected with the interior of a bottle when in position to be filled, and means for discharging the air from the said compressible air receiver before a second bottle is placed in position to be filled.

1,045,710. PNEUMATIC PIANO-ACTION. WALTER A. KRUCK, Camden, N. J.